# Electrical Stimulation versus Rebounding Exercise on the Degree of Genu Recurvatum in Children with Central Hypotonia

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**Abstract:** The purpose of this study was to provide insight into the effect of neuromuscular electrical stimulation on the quadriceps muscles versus rebounding exercise on the degree of Genu Recurvatum in hypotonic cerebral palsy children .Subjects: Thirty patients in with hypotonic cerebral palsy children (age ranges from 7 to 11 years were equally divided into two groups; control group (A) and study group (B). Group (A) received a designed physical therapy program for the treatment of hypotonic cerebral palsy in addition to neuromuscular electrical stimulation on the quadriceps muscles, while group (B) received designed physical therapy program for the treatment of hypotonic cerebral palsy in addition to rebounding exercise. The subjects were evaluated and scored functionally, using gross motor function measure scale (GMFM-88) and objectively, using Electrogoniometer. Plain-Radiographic at different time intervals; pretreatment and three months later during which they underwent the treatment program. Results: the results revealed statistically significant improvement in the measuring variables of both groups when comparing their pre and post treatment mean values. Comparing the two groups' post –treatment variables, significant difference is revealed in favor of the study group (B). **Conclusion:** The obtained results strongly support the introduction of rebounding exercise as an additional procedure to the treatment program of hypotonic cerebral palsy children.

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**Key words:** Hypotonic cerebral palsy, rebounding exercise; neuromuscular electrical stimulation; Genu Recurvatum

## 1. Introduction

Hypotonia is a disorder that represents low muscle tone (the amount of tension or resistance to movement in a muscle), often involving reduced muscle strength [1].

Hypotonia can be classified as central or peripheral. Central hypotonia originates from the central nervous system, while peripheral hypotonia is related to problems within the spinal cord, peripheral nerves and/or skeletal muscle [2].

Infants who suffer from central hypotonia are often described as feeling as they are rag dolls, a sac of jelly, or a pillow full of pudding easily slipping through one's hand. They are unable to maintain flexed ligaments on limbs, and are able to extend them beyond normal length [3].

An infant with central hypotonia exhibits a floppy quality or "rag doll" feeling as he/she is held. Infants with this problem lag behind in acquiring fine and gross motor developmental milestones. The most common symptoms of hypotonia involve problems with mobility and posture, breathing and speech difficulties, lethargy, ligament and joint laxity, and poor reflexes [4].

Floppy infant has the clinical signs of decreased resistance to passive movement and decreased tonic contraction of antigravity muscles "a decreased state of readiness for movement" functionally is impairment of the ability to sustain postural control and movement against gravity, producing delay in motor development with abnormal patterns of movement [5].

Central hypotonia may result in many musculoskeletal and posture problems. Genu Recurvatum is considered one form of these problems that should be assessed and measured. Genu Recurvatum is a hyperextension mal position between femur and tibia that can be considered postural fault, and considered as a common clinical presentation which places stress on the posterior surface of the knee [6].

Genu recurvatum is operationally defined as knee extension greater than 5 degrees, or hyperextension of tibiofemoral joint, it can be subdivided into:

1. Constitutional "Physiological" Genu recurvatum: generally bilateral, symmetric, <15 degrees, and asymptomatic.
2. Acquired "Pathological" Genu recurvatum: usually is unilateral or asymmetric bilateral, >15 degrees, and often symptomatic [7].

Individuals who exhibit pathological genu recurvatum may experience knee pain, display an extension gait pattern, weakness, and instability due to

poor proprioceptive control of terminal knee extension [8].

Genu recurvatum is a consequence of poor control over the knee joint due to muscle weakness, impaired tonus, and deficit in joint proprioception [9].

Proprioceptive input to central nervous system is very important for conscious awareness of joint position sense and motion so clinicians need to evaluate kinesthetic deficits and to design exercise programs to improve kinesthetic awareness. [10]

A rebounding is an exercise that exercises every cell in the body at once by helping the body increase its resistive load via trampoline rebounding. The use of rebound therapy with children with both physical and learning disabilities is expanding. [11].

Bouncing on a rebounder is an excellent method of reducing stress. It can put the bouncing person into a trance like state and totally relax. not only stabilizes the nervous system during the exercise period, but continues to help maintain equilibrium after one step off the device. The result is increased resistance to environmental, physical, emotional, and mental stress. It may possibly help an individual to avoid psychosomatic disease and mental or behavioral instability. [12].

Neuromuscular electrical stimulation (NMES) is an alternative and potentially more effective means than volitional exercise alone of increasing the force of muscles in appropriate patients.16 However, the use of NMES for increasing muscle force production has not been widely investigated in older adults,17 although NMES has the potential for effectiveness because it targets a greater proportion of type II fibers than volitional exercise alone[13] Most NMES programs reported in the literature for younger patients (<50 years of age) tend to mimic traditional training programs with 8 to 15 maximum contractions, 3 to 5 times per week. There appears to be a direct relationship between the intensity of the electrically stimulated contraction and the resulting gains in force production. [14].

## 2. Subject instrumentations and procedures

### 2.1. Subjects

Thirty hypotonic cerebral palsied children represented the sample of this study. They were selected from both sexes (12 males and 18 females), from El-Nabawy El-Mohandas Institute of Poliomyelitis and Physical Medicine at the area of Imbaba, Giza, Egypt. Their ages ranged from 5 to 8years. They were able to understand any command given to them, with an IQ level within normal range. Children participated in the study were free from any associated disorders other than hypotonia. They were free from any structural changes in the joints of the lower limbs; however. The study sample was divided randomly into two groups of equal number (A and B). Double blind evaluation was conducted for each child individually before and after three months of treatment.

### 2.2. Instrumentation

**2,2.1, For evaluation :**

I. DONG FANG Plain-Radiographic **Equipment**

II. Model F92-IJB, X051-20-40/125, 32 mm, (JAPAN). It was used to take radiographs of both knees for the detection of the genu recurvatum angles 2-Guymon Goniometer (LAFAYETTE type), (model 01129), USA. It is a digital bi-dimensional goniometer that can measure any joint angle or range of motion quickly and accurately .

**2.2.1.2. Functional scale.**

**1- Gross Motor Function Measure Scale (Gmfm-88).**

The gross motor function measure scale was designed to assess motor function, or how much of an activity the child can accomplish, rather than the quality of the motor performance or how the child performs the activity.

**2.2.2. For treatment**

**2.2.2 . Materials for treatment:**

**Mini trampoline.**

40 inches in diameter and about 12 inches high for a model with six legs, also have 40 inches long bar at the trampoline side which fixed with the trampoline by 3 longitudinal bars with 24 inches in height that gives child something to hold onto if child is at risk for falling due to disturbance of the balance. **2.3. Procedures**

**2.3.1. Evaluation procedures**

1- **2.3.1.1 Evaluation of the genu recurvatum angle by radiographic plain X-ray:**

a- Capture the genurecurvatum angle:

Unilateral standing (weight bearing) X-ray film was taken from the 90□ lateral prospective view, with a distance of 90cm from the radiographic equipment

b- (hold in two sides of the chair with both hands during the testing procedures Measuring the genu recurvatum angle from the X-ray film:

The angle which identifies the angulations of the knee joint is the tibiofemoral angle [(12)], which detected by determining the anatomical axis. The anatomical axis is the line lies longitudinally in the middle of the shaft of the long bones[15]

2- Evaluation of knee hyperextension range of motion by the electrogoniometer:

1) Calibration of the electrogoniom-eter:

After drawing a straight line on a large paper using the ruler the electrogoniometer border was adjusted at the line on the paper. Then the electrogoniometer was turned on and pressed to the zero key the electrogoniometer was applied on the child's knee for hyperextension assessment.

This method of calibration was repeated each time the device was used.

3- Evaluation of standing by the gross motor function measure scoring scale (GMFM-88):

By using the GMFM-scale each item of the scale was assessed for each **child** individually to determine his/her level of performance in different items of standing dimension, the score of each item was recorded, the total child score was calculated by adding all the items scores, then the percent score for standing was calculated by using the following equation:

Percent score for standing = (total child score / maximum score) X 100= …… %

2.4.1. For treatment

Procedures for Treatment:

The patients were divided into 2 equal groups:

**Group A:** Received traditional exercise program in addition to electrical stimulation for quadriceps muscles for thirty minutes.

Group B: engaged to extra exercise"rebounding on the mini trampoline". Rebound therapy should be used as part of a therapy program adding to existing therapies and not in isolation the treatment program was conducted three times / weak over a period of three months. we start bouncing slowly (warming up) while the therapist control and guide the bouncing rate in short blocks of 2 to 5 minutes, gradually increase the workout time as the endurance increases to reach target heart rate 50-70% of maximum heart rate, Then gradually decrease the intensity near the session end (cooling down).

## 3. Results

The raw data of radiographic plain X-ray: measured, range of motion by the electrogoniometer & gross motor function measure scoring scale in hypotonic cerebral palsied children were statistically treated to determine the mean and standard deviation of the measuring variable, for the two groups before and after three months of treatment. Student z-test was then applied to examine the significance of treatment procedures conducted in each group.

As revealed from Table 1 and Fig. 1 significant improvement was observed in the mean value of radiographic plain X-ray measured in group (A) at the end of treatment as compared with the corresponding mean value before treatment (P<0.01

Also, Table 1 and Fig. 1, showed a significant improvement in the mean value of radiographic plain X-ray measured in group (B) at the end of treatment as compared with the corresponding mean value before treatment ($P < 0.01$).

As revealed from Table 2 and Fig. 2, significant improvement was observed in the mean value of range of motion by the electrogoniometer measured in group (A) at the end of treatment as compared with the corresponding mean value before treatment (P<0.01 0.01).

Also, Table 2 and Fig. 2, showed a significant improvement in the mean value of range of motion by the electrogoniometer measured in group (B) at the end of treatment as compared

with the corresponding mean value before treatment ($P < 0.01$).

As revealed from Table 3 and Fig. 3, significant improvement was observed in the mean value of gross motor function measure scoring scale measured in group (A) at the end of treatment as compared with the corresponding mean value before treatment (1' < 0.01).

Also, Table 3and Fig. 3, showed a significant improvement in the mean value of gross motor function measure scoring scale measured in group (B) at the end of treatment as compared with the corresponding mean value before treatment ($P < 0.01$).

**Table (1):** Comparison of Post –treatment mean values of radiographic plain X-ray groups A and B in extension at 60 degrees.

| | Rt knee | | Lt Knee | |
|---|---|---|---|---|
| | Post A | Post B | Post A | Post B |
| X | 19.1 | 17.9 | 19.0 | 17.8 |
| ± SD | ±2.68 | ±2.46 | ±1.49 | ±1.47 |
| t-test | 11 | | 11.01 | |
| *p*-value | 0>0.01 | | 0>0.01 | |

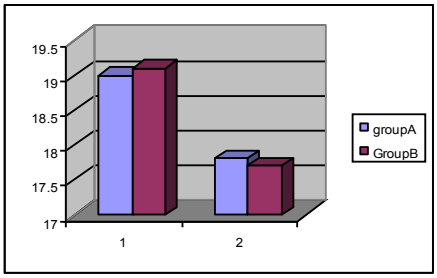


**Fig.(1):** Illustrating the pre and post treatment mean values radiographic plain X-ray measured) for groups A and B .Also, Table (2) and Fig.(2) showed a significant improvement in the mean value of balance measured in group (B) at the end of treatment as compared with the corresponding mean value before treatment.

**Table (2):** comparison of Post –treatment mean values of range of motion by the electrogoniometer measured between both groups

| | Rt knee | | Lt Knee | |
|---|---|---|---|---|
| | Post A | Post B | Post A | Post B |
| X` | 19.11 | 18.44 | 18.88 | 18.11 |
| ± SD | ±1.96 | ±2.0 | ±2.61 | ±2.08 |
| t-test | 4 | | 3.5 | |
| *p*-value | 0>0.01 | | 0>0.01 | |

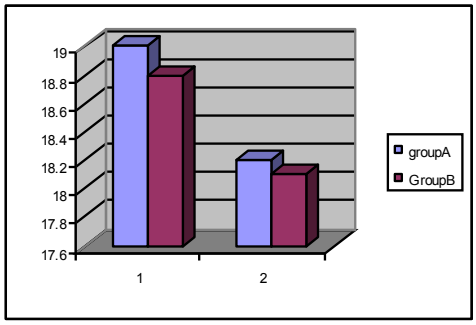


Fig. (2): illustrating the pre and post treatment mean values balance measured (points) for groups A and B.

**Table (3):**comparison of Post –treatment mean values of gross motor function measure scoring scale groups A and B in extension at 60 degrees.

| | Group A | | Group B | |
|---|---|---|---|---|
| | Pre | Post | Pre | Post |
| X` | 13.22 | 44.26 | 14.12 | 46.22 |
| ± SD | ± 3.9 | ± 40.5 | ± 3.7 | ± 4.5 |
| t-test | 4.98 | | 5.01 | |
| *p*-value | 0>0.01 | | 0>0.01 | |

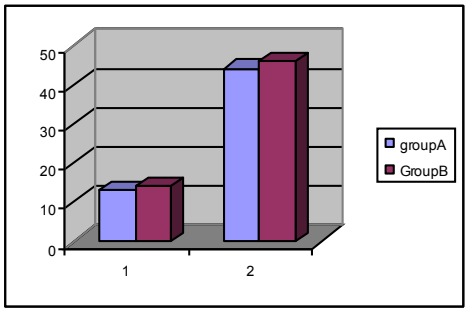


**Fig. (3):** illustrating the pre and post treatment mean values radiographic plain X-ray measured) for groups A and B.

**4.Discussion:**

The present study was essentially planned aiming to investigate the effect of Aquatic therapy program on the degree of genu recurvatum in children with central hypotonia. Thirty children with central hypotonia having bilateral different genu recurvatum angles ranged between 15 to 30 degrees participated in this study.

The selection of this angle was according to Loudon *et al.* [12]., who defined the genu recurvatum operationally as knee hyperextension greater than 5 degrees. Also they classified the genu recurvatum angle to: less than 15 degree (physiological, asymptomatic, and symmetric), and more than 15 degree (pathological, symptomatic, and asymmetric).

Selection of the genu recurvatum problem to be controlled in this study by the proprioceptive training came in agreement with the work of Lorenzo *et al.* [13], who reported that uncontrolled locking of the knee during standing and ambulation cause recurrent micro trauma which leads to degenerative changes and instability. So, the rehabilitation of the knee genu recurvatum should focus on biomechanical correction to improve biomechanical faults, to alleviate tissue stress and correct muscle imbalances. Also, the program should focus on proprioception training to teach the patient how to identify good knee alignment in static and dynamic postures, muscle control to improve absolute quadriceps strength and improve synchrony of lower extremity muscles, gait training to teach the patient the knee awareness during gait, and functional activities to carry over good knee alignment to function "Patients need to learn that 0 degree of knee extension is the normal knee position".

The exercise program applied 3 times/week for 3 successive months as according to **Newton,** [14] who recommended that the treatment of genurecurvatum requires repetitive training to re-establish a more ideal femorotibial alignment.

The age of the children in the present study was ranging from 5 to 8 years. This selection was based on the study of **Noda *et al.*** [15] (who used Aquatic therapy with children and young people aged from three to twenty years old, from profoundly multiply disabled patients who are totally dependent and wheelchair-bound to those who are mobile but have impaired tone and poor balance reactions, as well as with those with sensory modulation difficulties.

As regards the functional exercise program intervention it`s better to start rehabilitation program before the age of six or seven years. - Mac Keith Press. [16]., suggested that GMFM scores of children with CP plateau by this age.

Measuring the degree of genurecurvatum by using X-ray and goniometer is supported by the work of Laura *et al* [17]., who suggested that the radiographic examination complete the goniometry of the recurvatum deformity by calculating the lateral tibiofemoral angle of the knee. The same method was used by Sailer *et al.* who evaluated the genu recurvatum angle using the lateral radiograph in addition to the electrogoniometer.

The pre-treatment results in the current study may be clarified by the words of Martin *et al.* [18]., who attribute it to musculoskeletal and neuromuscular system impairments found in children with central hypotonia; these impairments include motor skills delay, hypermobile or hyperflexible joints, decreased strength, decreased activity tolerance, poor attention and motivation, and poor reflexes.

The improvement of the knee angle in the four groups may be due to the application of a designed exercise program which included a group of exercises representing the integral components of weight bearing

activities and directed toward functional tasks "The process by which the child initiated the movement and tasks".

Improvements of function in the four groups after application of the physical therapy program may be explained by motor learning favoring task specific and repetitive approach. This also confirmed by Trombly [19]., who reported that motor learning is a set of internal processes associated with practice or experience leading to permanent changes in motor behavior.

The physical therapy program was conducted to enable the child to perform the task, initially facilitate and guide the movement. Also, use of an unstable surface (mini-trampoline) disturbs balance, provides increased sensory stimulation through the joints and stimulates equilibrium reactions through stimulation of postural mechanisms as reported by Carr and Shepherd [20]..

Finally, the current work showed that the children with central hypotonia included in this study had achieved a significant reduction in genu recurvatum and improved functional behavior of standing, which could be explained by the effect of physical therapy program in addition to the effect of Aquatic therapy program. Exercises which helped these children to gradually gain greater control on their posture and movement allowed them for the development of skilled functional abilities, symmetrical movement, and good aligned posture.

**Conclusion:**

The obtained results strongly support the introduction of Aquatic therapy as an additional procedure to the treatment program of hypotonic cerebral palsy children.

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