To Study the Efficacy of Electromyographic Biofeedback Training on Dynamic Equinus Deformity and Gait in Children with Spastic Cerebral Palsy

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Abstract: *Cerebral palsy (CP) is caused by static lesion to a developing nervous system that primarily affects motor function. Spastic motor involvement is characteristic of most of these individual.Dynamicequinus is a common deformity that worsens the ambulatory ability of both diplegic and hemiplegic conditions. The use of electromyographic (EMG) biofeedback has been suggested as a training tool to improve the ability to increase activation of weak and partially paralyzed muscles and to decrease the activation of muscles affected by spasm or spasticity without regard to specific diagnosis. However, very few studies have reported the effects of EMG biofeedback on ankle function among children with spastic cerebral palsy .Objectives of the study was to increase the activation of tibialis anterior and to improve the functional ambulation.40 subjects were made part of the study on the basis of inclusion and exclusion criteria divided into two groups group A and B.Group A received traditional physical therapy exercises and electromypgraphic biofeedback and group B received only exercise program.The treatment duration was for 4weeks 3 sessions a week.The results were analysed using statistical tests that were paired and unpaired t-test and mannwhitneytest.The results showed significant improvement in the pre and post treatment.The conclusion of the study lended a favourable outlook to use biofeedback training in treatment of CP children, to improve functional ambulation and gait.*
Keywords: *Cerebral palsy, dynamic equinus deformity, gait, electromyography, biofeedback.*

I. Introduction

Cerebral palsy (CP) is caused by static lesion to a developing nervous system that primarily affects motor function. Spastic motor involvement is characteristic of most of these individual. (1). The term "cerebral palsy" also known as "static encephalopathy' refers to the symptom complex produced by a non-progressive central nervous system (CNS)lesion occurring during gestation or at birth, and resulting in some motor deficit. Cerebral palsy affects approximately 0.1 -0.20/o of all children, however, there is no familial or genetic inheritance pattern. (2)

The most common spastic deformity in cerebral palsy is equinus, which involves contracture of the gastrocnemius or the gastrocnemius-soleus muscle tendon complex (triceps surae). It may be combined with an equinovalgus deformity of the foot when there is associated pronation due to spastic peroneal muscles, or equinovarus deformity when associated with over-activity or spasm of the tibialis posterior muscle. (3).

Lower limb involvement is most apparent at the ankle joint. Dynamic equinus is a common deformity that worsens the ambulatory ability of both diplegic and hemiplegic conditions. The plantar flexors often co-activate with, and overpower tibialis anterior during swing, producing initial ground contact with the toe, rather than the heel. (1).The disability associated with cerebral palsy may be limited primarily to one limb or one side of the body, or it may affect the whole body. When young children with spasticity are learning to walk, their muscles become tight and their legs are unable to move into the right position at the right time. the spastic tone in the calf muscles that causes the foot to pointdown.There are various interventions for treating CP patients like physiotherapy plays a vital role such as: management of abnormal muscle tone, exercises to maintain joint range of movement, stretching programme for tight muscles, exercises to strengthen weak muscles, positioning advice to improve posture and alignment, development of gross motor skills. The other health professionals such as occupational therapists and speech and language therapists also are a part of team in treating CP patients.There are a wide variety of therapeutic interventions in use to improve ankle function in this population, including active and passive exercise, bracing, and participation in whole-body activities designed to improve overall ability to control and coordinate movement, electromyographic (EMG) feedback and electric stimulation also benefits children suffering from CP (1). EMGbiofeedback is the process in which the muscle activity of a person is recorded through electronic devices while also allowing the patient to see or hear this activity. Biofeedback training has an essential role in increasing the maximum torque, produced by the calf muscle (5).

Aims and objectives of the study
Statement of the study
To study the efficacy of electromyographic biofeedback training on dynamic equinus deformity and gait in children with spastic cerebral palsy.

Aim of the study
To evaluate the efficacy of electromyographic biofeedback training on dynamic equinus deformity and gait in children with spastic cerebral palsy.

Objectives of the study
To increase the activation of tibialis anterior.
To improve the functional ambulation.

Hypothesis
Null Hypothesis- There is no statistical significant effect of electromyographic biofeedback training on dynamic equinus deformity and gait in children with spastic cerebral palsy.
Alterative Hypothesis- There is a statistical significant effect of electromyographic biofeedback training on dynamic equinus deformity and gait in children with spastic cerebral palsy.

II. Review of Literature

Colborne (1994) Children with spastic hemiplegia secondary to cerebral palsy show disrupted patterns of work and power in gait. A computer-assisted feedback system was used to deliver EMG feedback from the triceps surae muscle group to walking subjects in conjunction with amplitude and timing targets for muscle relaxation and activation. Biofeedback of triceps surae muscle activity during gait was compared with physical therapy (PT) in a two-period crossover design, with intervening biomechanical gait analyses to assess the effects of each type of treatment. It is concluded that the feedback protocol might be an effective adjunct to physical therapy in hemiplegic children.

Dursun (2004) concluded that Children with cerebral palsy and dynamic equinus deformities may benefit from biofeedback treatment for ambulation. Thirty-six children with spastic cerebral palsy and dynamic equinus deformity were included in the study. The biofeedback group consisted of 21 children who each received EMG biofeedback training plus conventional exercise programme. The control group consisted of 15 children who each received conventional exercise programme only. Active range of motion of the ankle joints, muscle tone of plantar flexors, and gait function of the children were evaluated and compared. The biofeedback group displayed statistically significant improvements regarding tonus of plantar flexor muscles and active ROM of ankle joints ($p < 0.000$ for all parameters). Gait function showed statistically significant progress in both of the groups, but the biofeedback group was superior to controls.

Maenpaa (2005) concluded that Neuromuscular Electrical Stimulation (NMES) appears to produce sensory feedback from limbs by activating the spinal and supraspinal tracts and cortical body schema areas which are needed to produce voluntary movement. The ability to move the limbs in turn increases the activity of the children during the therapy sessions. MENS therapy as an add-on treatment produced at least temporary relief of myocontracture of the Achilles tendon in children with CP. The gained increase in ROM can postpone the surgical elongation of the Achilles tendon for years. The definite place of ES therapy in children with CP can be judged only after controlled trials.
Methodology

Study design- The study was conducted as the experimental study to evaluate the efficacy of electromyograhic biofeedback training on dynamic equinus deformity and gait in children with spastic cerebral palsy.

Research setting- Neurological physiotherapy research laboratory and out patient department of GianSagar College of physiotherapy, Ramnagar, Banur, Distt. Patiala.

Study duration- Six months.
Population- Spastic cerebral palsy patients from In and Out Patient Department of Paediatrics and Out Patient Department of Physiotherapy GianSagar Medical College and Hospital and Out Patient Department of GianSagar College of Physiotherapy, Ramnagar, Banur, Distt. Patiala.

Ethical approval and informed consent:- This study was approved by ethical committee of GianSagar Medical College and Hospital. And informed consent was taken from all the subjects before the initiation of the treatment. All the subjects were duly informed about the treatment protocols, time and duration of the treatment, risk factors and the precautions.

Sampling method- Random sampling method (on the basis of odd and even no. of grouping).

Sampling size– Forty subjects (two groups were divided on the basis of random sampling group- A (experimental group) and another group- B (control group).

Sampling criteria

Inclusion criteria

Age between 04-14 years

Diagnosed as diplegic or hemiplegic cerebral palsy with equinus deformity

Toe walking gait pattern

Able to walk independently with or without a walking aid

Normal visual and hearing capability

Exclusion criteria

Static deformity in lower limb (unilateral or bilateral)

 Non-cooperative patients

Underwent any surgery of ankle joint

Procedure

After the approval from the institutional ethical committee of GianSagar Medical College and Hospital the procedure was started.

After taking consent on the basis of inclusion and exclusion criteria subjects were assessed by electromyography and functional ambulation with functional ambulatory scale. Each patient was allowed to walk across the treatment room, during which the subject was observed and the mean value was considered as the actual score of functional ambulation.

Subjects belonging to the experimental group (A) were subjected to a traditional physical therapy program including:

Stretching exercises for Achilles tendon and hamstring muscles passively.

Proprioceptive training in the form of slow rhythmic approximation, touch and weight bearing- passive stretch and movement.Facilitation of postural reaction (righting, equilibrium, and protection).Gait training program- between parallel bars, using walkers, and climbing stairs ten repetitions, in addition to electromyographic biofeedback for dorsiflexors of the affected limb.

The subject were made sit upright (semi forward position) with feet flat against the floor. The recording electrode was placed and fixed on the belly of tibialis anterior muscle with the reference electrode five cm apart and distal to the active one and on the same line, the ground electrode was placed and fixed on the lateral malleolus of the affected side. The subject was instructed to watch the monitor for electromyographic biofeedback and the subject was given three active dorsiflexion training trials, each consisting of a single, continuous thirty seconds contraction of the tibialis anterior muscle with one minute rest between trails (8).

After a verbal command the subjects were asked to perform his/her maximal tibialis anterior contraction, the subject were encouraged to do his best on all trails. Each trail was repeated for 10 successive times per session. All patients of the experimental group were informed that feedback signals provide precise information concerning the course of the muscle contraction. Each session lasted for 30 minutes. (8).

Subjects belonging to the control group (B) received previously mentioned traditional physical therapyprogram only.

Treatment for both groups was continued for four weeks, three sessions per week. The recordings of electromyographic biofeedback were recorded before the treatment started and after ten sessions of recordings of electromyography and functional ambulation were again recorded to observe the results. (9).

Variables

Independent variables

- Electromyographic biofeedback
- Stretching exercises
- Proprioceptive training
- Gait training programme

Dependent variables

- Electromyography
- Functional ambulatory scale

III. Results

Pre treatment and post treatment readings were compared using standard statistical tools.
Paired t-test between the variables of electromyography in pre and post treatment
Unpaired t-test between the variables of post treatment of electromyography
Mann Whitney U test between variables of functional ambulatory scale

Table no. 1 comparison of Mean and SD of group A and B for functional ambulation.

	Pre	post
	Mean ± SD	Mean ± SD
GroupA	2.60±0.68	3.15±0.64
GroupB	2.75±0.65	2.95±0.60

Table no.2 Mean (in mV) and SD of group A and B for EMG biofeedback

	Pre	Post
Groups	Mean ± SD	Mean ± SD
Group A	5.05±0.29	4.88±0.30
Group B	4.99±0.63	4.97±0.64

Table no.3 Paired t-test between variables of EMG biofeedback in group A and group B.

groups Significant at 5%	t-value	Significant/non-significant
Group A	12.6	Significant
Group B	4.18	

Table no.4 Unpaired t-test between the variables of post values of group A and B of EMG biofeedback treatment

	Unpaired t-value	Significant/non-significant
Group A and B	0.60	Significant

Table no.5 Mann Whitney U-test between the variables of functional ambulatory scale

	Z-score	u-value	Significant/non-significant
Group A	2.44	109	significant
Group B	0.96	164	Non-significant

IV. Discussion

This study aimed at evaluating the efficacy of Electromyographic biofeedback training on Dynamic Equinus Deformity and Gait in children with spastic cerebral palsy aged 04-14 years. The following discussion intends to explain the observations made and the results obtained through this study in the light of the available scientific evidence. The subjects who suffered from dynamic equinus deformity following cerebral palsy or hemiplegic gait were taken in this study in accordance with electromyographic biofeedback training and physical therapy, as the improvement of gait is the major goal of this study. Cerebral palsy is a static encephalopathy that is characteristically non-progressive and is accompanied with postural disturbances. CP is a fairly common disease and the most important cause of childhood disability (10).During the therapy, re-education of the patients gait was especially emphasized. Using EMG biofeedback methods an attempt was made to achieve the planned effect via a reduction of spasticity and improvement in functional ambulation.In this study, patients were made to walk across the treatment room for the scoring of functional ambulation scale from 0-5. As we have included the patients who can walk (with or without support).The functional ambulatory

scale provides scoring related to walking for responsiveness and reliability of the scale. (11).In this study, the results shows significant values between the pre and post values of functional ambulation at <0.05. The comparison between mean and standard deviation of both groups i.e. mean ± SD of group A in pre readings is 2.60 ± 0.68 and post mean ± SD is 3.15 ± 0.64 where as pre mean ± SD of group B is 2.75 ± 0.65 and post mean ± SD is 2.95 ± 0.60. There is significant difference between mean and SD of group A. There is no significant difference between mean and SD of group B.The pre and post values of EMG biofeedback for group A and group B are significant at <0.05. The mean in (mV) and SD of group A in pre reading is 5.05±0.29 and in post reading is 4.88±0.30 where as in group B pre reading is 4.99±0.63 and post reading is 4.97±0.64 in treatment groups of EMG biofeedback. There is significant difference between pre and post values of group A and there is no significant difference between pre and post values of group B. The t-value was calculated between variables of EMG biofeedback in pre and post values of both the groups (group A and group B).Where in group A t-value is 12.6 and 4.18 is value of group B. Where the t-value is significant at the level of 5%.The value of unpaired t-value of group A and B is 0.60 which is significant at the level of 5%.The Mann Whitney U-test was calculated between the variables of functional ambulation where the result, in group A z-score is 2.44 and u-value is 109 the result is significant. In group B the z-score is 0.96 and the u-value is 164 the result is non-significant.The results of the present study shows compliance with the previous studies of (1) concluded that Children with cerebral palsy and dynamic equinus deformities may benefit from biofeedback treatment for ambulation. Thirty-six children with spastic cerebral palsy and dynamic equinus deformity were included in the study. The biofeedback group consisted of twenty one children who each received EMG biofeedback training plus conventional exercise programme. The control group consisted of 15 children who each received conventional exercise programme only. Active range of motion of the ankle joints, muscle tone of plantar flexors, and gait function of the children were evaluated and compared. The biofeedback group displayed statistically significant improvements regarding tonus of plantar flexor muscles and active dorsiflexion range of motion of ankle joints. We can say that the results of the present study are consistent maximally to the findings of the similar previous studies.

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