Effect of Biofeedback Training on Postural Control in Duchenne Muscular Dystrophy

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ABSTRACT

The purpose of this study was to evaluate the effect of biofeedback training on improving posture in scoliotic Duchenne muscular dystrophy (DMD). The study included twenty male patients with age ranged from 8 to 12 years old. They were selected on basic criteria to confirm the grade of scoliosis and absence of structural deformities. Patients were randomly divided into two equal groups. Cobb's angle of scoliosis and functional scale were measured pre and post the suggested period of treatment. The study group received a suggested program of biofeedback training for scoliosis, followed by a traditional program of physiotherapy treatment, while the control group received only a traditional program of remedial exercises. Treatment was conducted for twelve successive weeks. An improvement was noted in comparing the results of the study group, before and after treatment. The collected data after termination of the suggested period of treatment of both groups revealed significant improvement in the study group, utilizing biofeedback, compared to those of the control group. Such an improvement included reduction of Cobb's angle in addition to an increase in the functional activity. So, it should be emphasized that utilization of biofeedback in combination with the traditional physical therapy modalities is effective in treating scoliosis in Duchenne muscular dystrophy.

Key words: Duchenne muscular dystrophy, scoliosis, biofeedback.

INTRODUCTION

Duchenne muscular dystrophy (DMD) is a steadily progressive neuromuscular disease, with an X-linked recessive pattern of inheritance[13,21,22]. It causes loss of ambulation by the age of twelve years old. Once they are restricted to a wheelchair, many patients develop secondary complications such as contractures, scoliosis and respiratory problems[1,6,8].

As the child loses his functional skills due to decrease in strength, a waddling gait or bilateral Trendlenberg and lumbar lordosis will be evident. Scoliosis, joint contractures, muscle atrophy and obesity occur when a child loses ambulation skills[3,17,20].

Krebs[12] reported that biofeedback is used to improve motor performance by facilitating motor learning "behavioral learning" by using biofeedback signal motivation and arousal. Feedback is considered another significant variable for motor learning and it gives information about how the movement is performed and how to reach the goal. It is beneficial that the movement should be slow and under mental concentration at the beginning of motor training[14,18]. Biofeedback is effective in training neuromuscular dysfunction, both in voluntary relaxation of unwanted activity and improving strength of motion of the paretic muscles[10].

Aim of the study

The purpose of the present study was to investigate quantitatively the effects of the biofeedback training on improving posture in scoliotic Duchenne muscular dystrophy.

SUBJECTS MATERIALS AND METHODS

Subjects

Preparatory to this study, it was determined that the subjects chosen to participate should meet the following criteria:

- ✯ The angle of scoliotic curve ranged between 20° and 30°, as confirmed by X-ray examination of the spine.
- ✯ Absence of vertebral rotation (non-structural scoliosis).
- ✯ Have the ability to walk alone or with assistance.
- ✯ No surgical interference.
- ✯ No associated problems (eg. Shortening of the lower limbs.

Twenty scoliotic Duchenne muscular dystrophy were involved in this study, which was carried out in Abou El-Reesh and Kasr El-Ainy Hospitals, Faculty of Medicine, Cairo University. The sample included twenty boys, with age ranged from eight to twelve years. They were randomly divided into two equal groups; control and study groups.

Materials

A. For evaluation:

- ✯ X-ray apparatus.
- ✯ Vignos functional scale (Form 1).

Form (1): Shows the functional rating scale.

Grade	Activity
1	Walks and climbs stairs without assistance.
2	Walks and climbs stairs with aid of railing.
3	Walks and climbs stairs with aid of railing over 25 seconds for 8 standard steps.
4	Walks but cannot climb stairs.
5	Walks assisted, but cannot climb stairs or get out of chairs.
6	Walks only with assistance or with braces.
7	In wheelchair: sits erect and can roll chair and perform bed and wheelchair ADL.
8	In wheelchair: sits erect and is unable to perform bed and wheelchair ADL without assistance.
9	In wheelchair: sits erect only with support and is able to do only minimal ADL.
10	In bed: can do no ADL without assistance.

Adapted from Vignos et al (1963)[21]

B. For treatment:

Biofeedback machine (Biofed 901 Apparatus), which is an audiovisual device. It is a portable, having the ability to measure the average activity of the target muscles, convert and display it into visual and acoustic signals. It contains the following:

1) Audible part: In the form of:
   - Click: It produces a series of click sounds, which increases in speed as the contraction of the target muscle increases. The difference between minimum and maximum click rate is about 100/sec.
   - Tone: The resulting tone is either continuous or pulsating in accordance with setting of pulse switch.
2) Visual part: In the form of: Light bar, having 15 segment moving dots, displays three groups of green lights, yellow lights and red lights.
3) Electrodes: Three round metal plate surface electrodes, made of platinum, two round active recording surface electrodes (8 mm diameter) and one round reference surface electrode (1.5 cm diameter).

Methods

A. For evaluation:

1- The X-ray apparatus (antero-posterior view) to detect the degree of spinal curvature (Cobb's angle). Measurements were carried out while the patient was in standing position with the back against the upright cassette. The angle of the spinal curvature was measured by the Cobb's angle as follows:
   - The cephalic (upper most) vertebral body and the caudal (lower most) vertebral body of the scoliotic curve were determined.
   - Two intersecting perpendicular lines, one from a line, drawn through the superior surface of the apical vertebral body and the second from a line through the inferior surface of the caudal vertebral body of the curve.
   - The angle formed by the intersection of the two perpendicular lines was the Cobb's angle[7,11].

2. Assessment of functional scale for each subject was done before and after treatment for both groups through Vignos functional rating scale (Form 1)[21].

B. For treatment:

Patients belonging to the control group received a physical therapy program, which comprised strengthening the abdominal and trunk extensors, stretching tight structures on the concave side of the curve, stretching tight hip flexors and erector spinae muscles, gait training and breathing exercises. Duration of each treatment session lasted about 45 minutes. On the other hand, the study group patients were exposed to the same line of treatment in addition to biofeedback training. The biofeedback machine and the loudspeaker system were prepared, adjusted and arranged in front of the subject in a horizontal plane, at the level of his sight. The three surface electrodes were covered with a fine layer of gel. The recording sites were located at the belly of the thoracic paraspinous muscles. The skin over the recording sites was prepared by cleaning with alcohol gently to obtain the minimum skin resistance. The recording sites were marked. The two surface recording electrodes were placed and fixed on the recording sites. The ground surface electrode was placed and fixed on the spinous process of the apex of the major scoliotic curve[10,15].

The instrument was switched on, the tone, frequency and sound volume were adjusted and the subjects were instructed to watch the colored leads and to hear the sound of the loudspeaker. The desired movement was demonstrated and the patient was given three active training trials, each consisted of a single continuous, 30-seconds contraction of the target muscles, with one-minute rest between trials. After verbal command, the patient attempted to initiate a voluntary contraction and then improve upon that contraction throughout 30-seconds trial period to provide substantial exercise, while avoiding under fatigue. Biofeedback training was conducted to these patients for 15 minutes.

All patients were treated for five days per week for twelve successive weeks. Each treatment session lasted about 45 minutes. Comparison of each patient's data at the end of the treatment period to that of his pre-treatment measurements resulted in calculated change for each variable.

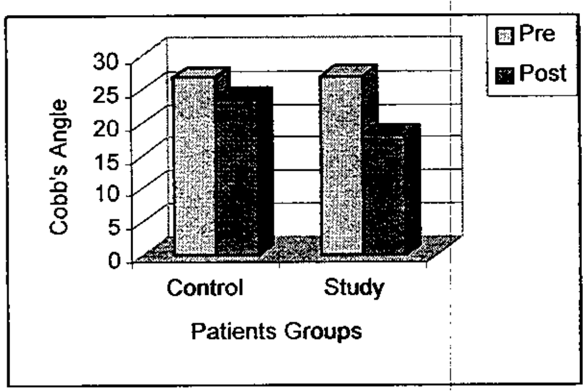
RESULTS

The collected data were fed into computer for statistical analysis. The descriptive statistics, which included the mean, standard deviation (SD) and standard error of the mean (SE), were calculated for all patients. The paired t-test was done to compare between the mean difference for all subjects. Alpha point on 0.05 was used as a level of significance.

In this work, the effect of biofeedback training on improving posture in scoliotic DMD was evaluated. As shown in table (1) and fig. (1), the mean value of Cobb's angle before training was 26.8 ± 4.7093° in the control group, while decreased after twelve weeks of treatment to 23.7 ± 3.7727°. The mean difference was 3.1°, representing a percentage of change of 11.57 %, which proved a significant improvement (t = 7.1494, P < 0.001). Concerning the study group, the mean value of Cobb's angle before training was 26.9 ± 5.5668°, while after training the mean value was 18.2 ± 4.5898°, with a mean difference of 8.7°. The percentage of change was 32.34 %, which showed a significant improvement (t = 15.9020, P < 0.0001).

Table (1): Shows the mean values of Cobb's angle (°) in both groups before and after treatment.

Variable	Control		Study	
	Pre	Post	Pre	Post
X	26.8	23.7	26.9	18.2
SD	± 4.7093	± 3.7727	± 5.5668	± 4.5898
SE	1.4903	1.1939	1.7616	1.4529
MD	3.1		8.7	
%	11.57		32.34	
t	7.1494		15.9020	
p	< 0.001 Sig.		< 0.0001 Sig.	



in both groups before and after treatment.

In this work, the effect of biofeedback training on improving posture in scoliotic DMD patients was evaluated. As shown in table (2) and fig. (2), the mean value of Vignos functional scale (VFS)[21] before training was 5.2 ± 0.7888 in the control group, while after training the mean value was 4.6 ± 0.8433, with a mean difference of 0.6 and a percentage of change of 11.54 %. These results revealed that there was a significant difference of functional activity in the control group (t = 2.7113, P <

0.025). In the study group, the mean value of VFS before training was 5.3 ± 0.8233, while after training was 3.4 ± 0.8433, forming a mean difference of 1.9 and a percentage of improvement of 35.89 %. These results indicated a significant improvement of functional activity in the study group (t = 10.5791, P < 0.0001).

Table (2): Shows the mean values of functional scale grades in both groups before and after treatment.

Variable	Control		Study	
	Pre	Post	Pre	Post
X	5.2	4.6	5.3	3.4
SD	± 0.7888	± 0.8433	± 0.8233	± 0.8433
SE	0.2496	0.2669	0.2605	0.2669
Post-Pre	0.6		1.9	
%	11.54		35.89	
T	2.7113		10.5791	
P	< 0.025 Sig.		< 0.0001 Sig.	

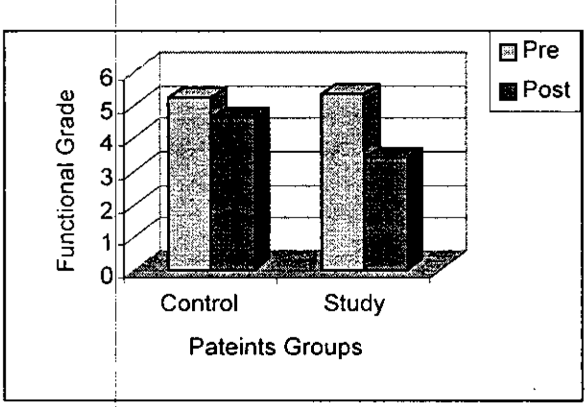


Fig. (2): Shows the mean values of functional scale grades in both groups before and after treatment.

DISCUSSION

Duchenne muscular dystrophy (DMD) is a neuromuscular disorder of childhood onset, which cannot be cured. There is a variety of management options, available for prevention and treatment of the complications[17,22]. The aims of physiotherapy are prevention of contractures, maintenance of mobility, increase muscle strengthening and improvement of respiratory functions by teaching of specific exercises and stretching[2,4]. Psychological support is a vital part of the management of DMD patients and their families[5,21].

Basmajian[3] reported that biofeedback is used to improve motor performance by facilitating motor learning "behavioral learning", through using biofeedback signal motivation and arousal. He also added that feedback is effective in treating voluntary relaxation of unwanted muscle activity and improving strength of the paretic muscles.

The results of the present study proved that there is a positive statistical significant changes in postural control and Cobb's angle in the study group, which received biofeedback training, compared to those in the control group. These improvements are attributed to the precise information of muscle contraction and reinforcement, provided by biofeedback (visual and auditory) signals.

The results of the present work coincide with those reported by Jeffery et al.,[10], Krebs[12] and Monica et al.,[15]. They mentioned that biofeedback is rapidly becoming an adjunct modality in the treatment of various musculoskeletal and neurologic disorders. The results also came in agreement with Bunnell[5], who stated that using biofeedback in treatment of scoliosis could enhance the degree of Cobb's angle.

Jean[9] reported that biofeedback may be used for assisting the patient to attain the greatest level of muscle activation of spasmotic muscle in order to attain balance between agonist and antagonist muscles, which was achieved in this study. Additionally, the results were also supported by Krebs[12], who stated that when subjects were trained by biofeedback, the output of their muscles would be increased more than those trained in a non-feedback manner.

There are two possible explanations for the effect of biofeedback. They are either that introducing the auxiliary feedback loop develops the new neural pathways or persistence of old cerebral or spinal pathways. The internal awareness provided by the auditory and visual responses to peripheral motor act appears to be a powerful reinforcement and new forms of conjunction around the cortical level are recruited[16,19].

So, the present study proved that biofeedback is an effective method in treating scoliosis in muscle diseases and in improving motor performance. This can be accomplished by facilitating motor learning through biofeedback signal motivation and arousal.

CONCLUSION

At the end of this study, it can be concluded that the results collected from this study indicated significant effects of biofeedback training on improving posture and functional activity in muscular dystrophy patients.

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الملخص العربي

تأثير التدريب باستخدام التغذية الحيوية على التحكم في القوام عند ضمور العضلات

تهــدف هــذه الدراسة إلى تقويم تأثير التغذية الحيوية على تحسن القوام (الجنف) عند ضمور العضلات، فقد تم إجراء هذا البحث على عشرين طفلا ممن تراوحت أعمارهم من ثماني إلى اثني عشرة سنوات، قسمت العينة إلى مجموعتين متساويتين ضمت كل مجموعة عشرة مرضى "المجموعة الضابطة والمجموعة محل البحث"، عولجت المجموعة الأولى (الضابطة) باستخدام العلاج الطبيعي التقليدي في مــثل هــذه الحالات بينما تم علاج المجموعة التجريبية (محل البحث) بواسطة نفس الأساليب السابقة بالإضافة إلى جهاز التغذية الحيوية، واســتمر العلاج لمدة ١٢ أسبوعا متصلة، وقد تم إجراء الاختبارات المناسبة للمجموعتين لقياس زاوية انحناء العمود الفقري وكذلك معدل الأداء الوظيفي قبل وبعد فترة العلاج، وأظهرت النتائج حدوث تحسن ذو دلالة إحصائية في مرضى المجموعتين بعد انتهاء فترة العلاج مع وجود فروق إحصائية واضحة لصالح المجموعة محل البحث، وبذلك يعد العلاج باستخدام التغذية الحيوية علاجا فعالا للمساعدة في تحسن القوام لدى الأطفال المصابين بضمور العضلات.