Effect of Surface Electrical Stimulation on Scoliosis in Children with Cerebral Palsy

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ABSTRACT

Background and purpose: *The use of electrical stimulation for the treatment of scoliosis was first proposed in 1857.Clinical trials were begun by transcutaneous electrical stimulation devices. Short term results implied clinical success in arresting curve progression. The purpose of the present study was to study the effect of surface electrical stimulation on scoliosis curve in children with spastic cerebral palsy.* ***Subjects:*** *Thirty cerebral palsy children were involved in this study after meeting specific inclusion criteria. The inclusion criteria: age: 3-10 years, diagnosed as spastic cerebral palsy by pediatric neurologist. All children having scoliosis with thoracic C-curve 10-30 degree according to Cobb's angle. The children were divided randomly into two groups of equal number study group and control group.* ***Procedures:*** *The study group was treated by surface electrical stimulation in addition to usual physical therapy while the control group was treated by usual physical therapy only.* ***Measurements:*** *All children were assessed pre and post intervention through measurement of scoliotic curve by Cobb's angle.* ***Results:*** *The result of the present study shows that there was no significant difference pre and post treatment in both groups.* ***Conclusion and discussion:*** *In spite of there was little reduction in scoliotic curve in the study group but it was statistically non significant. The time intervention and the number of the participant may be the most important factors should be considered during discussion of the results of the present study.*

INTRODUCTION

Scoliosis in cerebral palsy is not uncommon and occurs in approximately 25% of patients, with the incidence increasing in proportion to the severity of the neuralgic involvement. Scoliosis is most common in patients with spastic cerebral palsy and even more common in person with spastic quadriplegic cerebral palsy, in which the incidence is approximately 60% to 75%[1].

Madigan and Wallace 1981.documented scoliosis in 75% of patients with spastic quadriplegia, whereas only 68% of spastic diplegic. They also reported that 61% of patients with cerebral palsy who where independent sitters had scoliosis, whereas 75% of patients with no truncal balance had scoliosis[2].

Progressive scoliosis is a common problem in patients with cerebral palsy, with recent showing that nearly one in seven will ultimately develop clinically significant spinal deformity (Bunnell et al 1976)[3].

Several factors have been associated with a rate of curve progression in patients with cerebral palsy. The greater the magnitude of the curve, the more likely is its subsequent progression. Previous reports suggest that an association exists between the early onset of scoliosis and the poor prognosis for curve progression Bunnell et al 1985[4] labored[5] 1986.

The use of electrical stimulation for the treatment of scoliosis was first proposed by Seiler of Paris in 1857[6]. Interest, however was

short lived and this concept remained dormant until the 1970s. It was at this time that animal studies by Olsen[7,8] and McCollough[9] using implantable electrodes in the paraspinal musculature showed evidence of curve production and correction. Clinical trials were begun by Bobechko[10] with implantable electrodes and by McCollough[11] and Axilgaard[12,13] with transcutaneous electrical stimulation devices. Short-term results implied clinical success in arresting curve progression. With limited follow-up reports of greater than 80 clinical success have appeared in the literature. The proposed advantages of using this type of treatment have included freedom from bracing the need for only part time treatment and an improved self image in the affected adolescents[12,13].

Research by Axelgaard et al., in 1976[14] demonstrated that acute scoliosis of up to 50 degrees could be induced in straight cat spines from electrical surface stimulation applied to the lateral trunk musculature. Axelgaard et al.,[15] showed in another study that idiopathic scoliosis in 30 patients could be actely reduced by surface stimulation.

Bertand et al., 1990[16] reported that transcutaneous lateral electrical surface has been advocated as a treatment for idiopathic scoliosis. Its effectiveness has been variable. Some investigators report effectiveness equal to brace treatment[12,17], whereas other report minimal to no effect on curve progression[18,19]. Bylund et al., 1987[18] found that the lateral electrical stimulation has not been an effective treatment for scoliosis. The study included eighteen patients with scoliosis were treated with lateral electric surface stimulation. For (23%) discontinued the program because of discomfort, five did not carry through an adequate treatment program, and nine (50%) coped with a proper program. In spite of a good initial correction, five patients in the latter group progressed during treatment. The scolitron stimulator was used. The two coetaneous electrodes were placed laterally on the back on the convex side of the curve. Stimulation took place during sleep (8 h/night).

Bradford et al., 1983[20] studied 30 patients have been treated for idiopathic scoliosis with surface electrical stimulation using the electro spinal Orthosis. The criteria for selection were: patients who were skeletally immature, single thoracic, thoracolumbar or lumbar curvatures between 30 degrees with 5 degrees of documented progression in one year. Patients with previous treatment were excluded from the study. All patients were less than 15 years of age. Curve amplitude was between 25 degrees and 35 degrees. Curve pattern was single thoracic in 28 patients, thoraco-lumbar in one, and lumbar in one. Five patients were excluded from the evaluation of the results of stimulation of the correction of the curve. Of the 25 patients remaining. One was improved, 14 were stable, two had mild acceptable progression (less than 10 degrees with no need for further treatment), and eight had an unacceptable progression greater than 10 degrees requiring some form of alternative treatment. The authors concluded that significant improvement in the curvatures under treatment was extremely unlikely, that progression may have been stopped in some curves. That the curvatures under 30 degrees had the best results, and that curvatures that do not respond to surface electrical stimulation are not likely to respond to a Milwaukee brace treatment.

Schutt et al., 1982[21] took thirty-seven patients with eighty-four curves to be treated by surface electrical stimulation. The results were compared with Milwaukee brace treatment. Patients with measurement between 20 degrees and 40 degrees with documented

progression of 5 degrees on curves less than 25 degrees and 3 degrees on curves between 25 degrees and 29 degrees were selected for the study. 18% of the treated curves resulted in marked improvement and 71% were unchanged after wearing the unit an average of eighteen months. This resulted in 89% of the curves treated by electrical stimulation showing no progression. They concluded that surface electrical stimulation has been very effective in treating high thoracic curves which are not amenable to brace treatment. Complications of treatment have been few, primarily a skin rash related to electrodes and tape. Two patients developed electrode kindling. Patient acceptance of this modality of treatment has been excellent. No patient was unable to tolerate stimulation as a form of treatment for scoliosis. El-sayyad and Conine 1994[22] studied thirty children with idiopathic scoliosis divided into three groups; the first received exercise only, the second was treated by exercise and bracing while te third one was treated by electrical stimulation and exercise. They reported that there're was a decrease in the scoliotic curve 2-4 degrees after 12 weeks of intervention.

The purpose of the present study was to investigate the effect of surface electrical stimulation on scoliotic curve in children with spastic cerebral palsy.

SUBJECTS

Thirty cerebral palsy children (mild to moderate spastic diplegic CP) were participated in the study after meeting specific inclusion criteria.

Children divided randomly into two groups of equal number, study group and control group. Children collected from different hospitals and rehabilitation centers in Riyadh City. Ethical committee of physiotherapy department in King Saud University approved the study and parents, who informed that they were free to withdraw their child from the study at any time, singed a written consent.

Inclusion criteria

- Age 3-10 years.
- Diagnosed as spastic diplegic cerebral palsy by pediatric neurologist.
- Having scoliosis with thoracic-C-curve between 1030 degrees (Cobb angle).
- Guardian signing a written informed consent and sufficiently motivation to participate.

Exclusion criteria

1- Children with medical problem:
a) Children with history of cardiac problem.
b) Children with history of acute medical problem.
c) Children with epilepsy.
d) Children who perform surgery with the last 6 months.
2- Children with S-curve.
3- Children who live out Riyadh.

Intervention

- Study group: this group received surface electrical stimulation (E.S) for 8 hours (sleeping time) Daily for 3 months addition to traditional physical therapy.
- Control group: this group continued in usual physical therapy treatment.

Program of study group

- The electrical stimulation was applied for 8 hours (sleep hours) daily for 3 months.
- The electrical stimulation was applied by parent or guardians after well training about application of electrical stimulation and the child have is seen by the researcher weekly, to check the electrical stimulation application.

Electrical stimulator

- Pulse rate: 25 pulses/ second.
- Pulse width: 200 microseconds.
- Duration: 5 seconds on and 10 second off.
- Intensity: for the maximum muscular contraction tolerated.
- The treatment done during sleeping time (8 hours) for 3 months.

PROCEDURE

Screening test: To select the study patients from children with cerebral palsy we did screening test, which is subjective test for scoliosis, the examination starts with the therapist sitting behind the undressed patient. Note the height of the shoulders, the counter of the flanks, and the prominence of iliac crest. The waist line and the hanging arms form a triangle that can be compared on both sides. The line of spinous processes can be followed visually and by palpation. If the child can't stand alone, he can stand with support from front by assistant holding his hands, while his feet supported on the bed.

The patient should bend forward with completely relaxed arms (as much as she can). The profile of posterior chest wall should be noted for any obvious rib hump or bulge. This forward bending test is the most significant finding. Repeat this process from the front. Then the child should be examined from the side as he or she bends forward.

Measurement

Initial roentgenograms include lateral and anteroposterior (AP) films of the entire spine to confirm persistent of thoracic-c-scoliosis curve more than 10 degrees up to 30 degrees using Cobb method as objective measurement.

Scoliosis curve in all children of both groups will be measured pre and post intervention by Cobb's angle which is the most objective measurement for scoliosis.

Application of electrical stimulation

Therapist explained the stimulator and home treatment to parents. Each patient received a manual that contains the necessary instruction for proper use of electrical stimulation, a diagram showing the parents where to put the electrodes, a time schedule for the 1st week of stimulation. Parents can keep a diary and record the time stimulation was applied, at what amplitude, the time of stimulation discontinued and any problems or comments. The diary reviewed by therapist at each follow-up visit to assist in judging compliance and to identify trends or problems surface electrical stimulation was applied at the first time in the clinic to show the parents of patients of patients the place of electrodes and teach them how to use the stimulator. The intensity increased gradually also the time of treatment increased gradually until reach 8 hours during sleeping time through the first week of treatment.

The patients have seen three times per week to be insuring about the electrodes placement and to know about any complication (such as skin rash due to the electrodes and tape). This problem usually responds to skin-toughening agents and topical cream. If patient has a severe rash, we discontinue the stimulator for a few until the rash disappears.

Electrodes placement

Apical vertebra of the curve will be identified with the physician. For thoracic curves, this vertebra is located by palpation by counting down from C7. The apical rib on the convex side of the curvature is palpated laterally to the midaxillary line. Electrodes are then placed symmetrically above and below

this point. The important factor is that the electrodes remain within the boundaries of the curvatures. (For example, in treating a curve from T6 to T12, the upper electrode should be no higher than the 6^{th} rib and the lower electrode no lower than the 12^{th} rib). Individual physical characteristics (i.e., are the nearly horizontal or do they slant vertically) require that the therapist try different electrode position. The therapist selects the position that produces the direction. Distance between the two electrodes depends on curve and trunk size[22].

Exercises of Control group

1-Erect position of pelvic tilting: leaning against the wall of erect tilting table, the feet close to the wall and the knees is extended, and then the low back is pressed to the wall.

2-Pron pelvic tilting exercises: the quadriped position is assumed, the lower back is arched and lowered.

3- Distraction exercise for posture, By attemping to elevate a weight placed on the head while the child is standing against the wall.

4- Hyper extention exercise: In pron position (using medical ball), encourage the child to elevate head and shoulders to extend the upper spine.

5-Crawling exercise: The starting position is the quadriped position: As the right leg is extended with simultaneous overhead extention of the right arm, the spine is laterally flexed causing it to convex to the right side.the opposite movement occurs according to thespinal curve.

6- Stretching exercise: using tme medical ball with proper size, the child on his convex side on the ball, and the

N.B. All the exercises mentioned above were performed firstly with assistance from the physiotherapist and then encourage the child to perform the exercises by himself with motivation.

RESULTS

Table (1): Comparison between mean values of curve angles of both groups pre and post treatment.

Group	Pre	post	MD	t-value	p	Sig.
Control	18.53±2.615	18.13±2.264	0.40	1.46	0.164	Non sig.
Study	19.8 ±3.321	18.73±2.789	1.07	1.835	0.088	Non sig.

Pre= before treatment Post= after treatment MD= mean difference Sig.= significancy

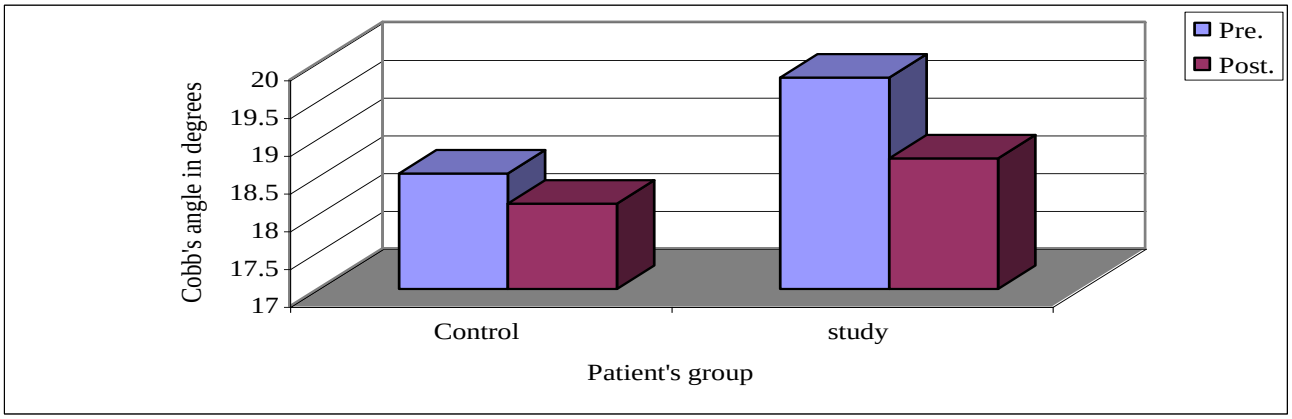

Fig. (1): comparison between mean values of curve angle of oboh groups pre and post treatment.

DISCUSSION

The results of the present study indicate that is no significant change in scoliotic curve in children with spastic C.P following surface electrical stimulation in three months.

On the other hand we can say claim that the intervention of the present study in the form of electrical stimulation and traditional exercise had been succeed in halting progression of curve along the time of intervention.

This preservation may be explained in part by the muscle strengthening effect of electrical stimulation, which may help to hold the curve in the correct position.

Treatment with surface electrical stimulation (S.E.S.) has certain advantages that are now obvious. A treatment requiring night time (8 hours) as opposed to around the clock (23 hours) use is more desirable, as it allows children to participate in a lifestyle that is similar to that of their peers. Or making the routine exercises for C.P children. Also electrical stimulation allows children to perform physical activities, which is very important for growing children, for that reason the electrical stimulation has advantage of superiority on bracing which severely limits The physical activity.

Comparing S.E.S with braces in treatment of scoliosis in children, psychological problems as commonly reported as a results of brace and often lead to non compliance.

Psychological testing of S.E.S patients has not been done, but according to parent reports on the quastionnairs, 42% of brace patients (BP) exhibited negative personality changes. Formal psychological testing of lateral electrical surface stimulation (S.E.S) patients similar to that testing of brace patients, should be documented before conclusive statement can be made regarding the psychological benefits of LESS over brace treatment.

The cost of the bracing is another factor make the SES. Superior to bracing, with the consideration of the cost of braces as the child grows, while only one stimulator is requiring for the entire treatment period of a patient receiving S.E.S.

Proper sleep is important for any growing child, some of children (20%) reported that they were unable to sleep will with S.E.S. We overcome this problem by informing parents to turn up the amplitude of

the stimulator only after the child had fallen a sleep.

REFERENCES

1- Lonstein, J.E.: Spine deformities due to cerebral palsy, In: Weinstein SL, ed. The pediatric spine: Principles and practice. Philadelphia: Lippincott Williams and Wilkins., 797-807, 2001.
2- Madge, R.R. and Wallac, S.L.: Scoliosis in the institutionaluiz cerebral palsy population spine., 6: 3838-3890, 1981.
3- Bunnell, C., Brounje, Crow, T. and Tjpracp, I.: Bar scoliosis in cerebral palsy. J Bone joint sury., 58:328-336, 1976.
4- Bunnell, C.B., Brow, Je Perry, J. and Waliniski, T.: Evaluation of treatment of paralytic scoliosis Rancho los amigos hospital. Bone joint sury., 57: 206, 1985.
5- Laborde, J.M.: The effectiveness of surface electrical stimulation in improving quadriceps strength and gait of young CP patients. Development Medicine and Child Neurology., 28(supple. 53): 26-27, 1986.
6- Cynthial, L., Durto, D.C. and Kimberly, J.: Keene, B.A Electrical muscle stimulation in the treatment of progressive adolescent idiopathic scoliosis: A literature Review.J. Manipulative and Physiological Therapeutic, 8(4): 1985.
7- Olsen, G.A., Rosen, H., Stoll, S. and Brown G.: The use of muscle stimulation for inducing scoliotic curves: A preliminary report. Clin Ortho and Rel Res., November-December 113: 198-211, 1975.
8- Olsen, G.A., Rosen, H. and Hohn, R.B.: Slocum B. Electrical muscle stimulation as a means of correcting induced canine scoliotic curves. Clin Orthop and Rel Res. June. 125: 227-235, 1977.
9- Mc Collough, N.C.: Nonoperative treatment of idiopathic scoliosis using surface electrical stimulation. Spine., 11:802-804, 1986.
10- Bobechko, W.P., Herbert, M.A. and Friedman, H.G.: The treatment of scoliosis using electro-spinal instrumentation. Orthop. Trans., 2: 281, 1978.
11- Mc Collough, N.C.: Surface electrical stimulation in idiopathic scoliosis: Current study group results. Minneapolis, Minnesota, Medtranic Inc, 1984.
12- Axelgaard, J. and Brown, J.C.: Lateral electrical surface stimulation for the treatment of progressive idiopathic scoliosis. Spine, 8: 242-260, 1983.
13- Axelgaard, J., Brown, J.C. and Nordwall, A.: Correction of spinal curvatures by transcutaneous electrical muscles stimulation. Spine, 8: 463-481, 1983.
14- Axelgaard, J., Brown, J.C. and Harada, Y.: Lateral surface stimulation for the correction of scoliosis. Proceedings of the 30th annual Conference on Engineering in Medicine and Biology. Los Angles, CA, The alliance for Engineering in Medicine and Biology, 282, 1977.
15- Axlgaard, J., Brown, J.C. and Mc Neal, D.R.: Lateral electrical surface stimulation for the treatment of progressive scoliosis. In popovic D (ed), proceedings of the 6th international symposium on external control of human extremities, Dubrovnik, Yugoslavia, 63-70, 1978.
16- Bertrand, S.L., Dravirc, D.M., Lange, N., Lucas, P.R., Deutsch, S.D., Herndon, J.H. and Roberts, J.M.: Electrical stimulation for idiopathic scoliosis. Clin. Orthop., Number 276: 176-181, 1992.
17- Fisher, D.A., Rapp, G.F. and Emkes, M.: Idiopathic scoliosis: transcutaeous muscle stimulation versus the Milwaukee brace. Spine, 12: 987-991, 1987.
18- Bylund, P., Aaro, S., Gottfries, B. and Jansson, E.: Is lateral electrical surface stimulation an effective treatment for scoliosis? J. Pediatr. Orthop, 7: 298, 1987.
19- Carr, W.A.: Electrical stimulation for treatment of scoliosis in a group of high risk progressive patients. Presented at the 22nd annual meeting of the scoliosis Research Society, Vancouver, British Columbia, Sept. 15-19, 1987.

20- Bradford, D.S., Taguy, A. and Vanselow, J.: Surface electrical stimulation in the treatment of idiopathic scoliosis: Preliminary results in 30 patients. Spine, 8(7): 757-764, 1983.
21- Schutt, R.C., Brown C.W., Tiefel, L.C., Odom, J.A. and Donaldson, D.H.: Surface electrical stimulation for the treatment of scoliosis. Biomed. Sci. Instrum, 18: 83-85, 1982.
22- El-Sayyad, M. and Conine, T.: Effect of exercise, bracing and electrical stimulation on idiopathic scoliosis: a preliminary study. International Journal of Rehabilitation research, 17: 70-74, 1994.
23- Willinks, K.E. and Gibson, D.A.: The pattern of spinal deformity in Duchenne muscular dustrophy. J. Bone Joint Surg., 58-A, 1976.

الملخص العربى

تأثير التنبيه الكهربي السطحى على الانحراف الجانبي للعمود الفقري(الجنف) في الأطفال المصابين بالشلل الدماغي المتصلب

تهدف هذه الدراسة الى بيان اثر التنبيه الكهربي السطحى على الانحراف الجانبى للعمود الفقرى فى الأطفال المصابين بالشلل الدماغى المتصلب.

اشتملت الدراسة على ثلاثين طفلا مصابا بالشلل الدماغى المتصلب تتراوح أعمارهم بين 3-10 سنوات ، جميعهم يعانون من انحراف جانبى بالعمود الفقرى من 10-30 درجة حسب القياس بزاوية كوب.

تم تقسيم العينة عشوائيا الى مجموعتين متساويتين فى العدد،إحداهما تجريبية والأخرى ضابطة. تخضع المجموعة التجريبية الى العلاج بالتنبيه الكهربي بالإضافة الى العلاج الطبيعي التقليدى بينما تعالج المجموعة الضابطة بالعلاج التقليدى فقط ، وكانت مدة البرنامج العلاجي ثلاثة أشهر، تم قياس زاوية الانحراف بالعمود الفقري قبل وبعد العلاج عن طريق زاوية كوب.

ولقد أشارت النتائج الى عدم وجود انخفاض ذي دلالة إحصائية بزاوية الانحراف فى كلا المجموعتين. وفى الوقت نفسه لم تشر النتائج لوجود زيادة فى زاوية الانحناء ، الأمر الذي يشير الى ثبات زاوية الانحناء على طول فترة العلاج والذي يعد نجاحا فى حد ذاته الى البرنامج العلاجي والتنبيه الكهربى السطحي.