

Comparison Between Selected Physical Therapy Program and Bracing on Pulmonary Function in Mild Idiopathic Scoliosis

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ABSTRACT

In order to study the effect of idiopathic scoliosis on lung capacity and the validity of a physical therapy versus bracing, thirty students with average Cobb angle of 21.6 ± 6.06 degrees were selected. Their chest mobility, vital capacity, forced vital capacity, maximum voluntary ventilation and respiratory rate were recorded pre and post treatment. The subjects were divided into two equal groups, (I and II). The latter used Boston brace while the former was subjected to a physical therapy program included strengthening and stretching exercises for the back muscles, breathing exercises and faradic stimulation. This program was repeated for five days/week for twelve weeks. The results of group I showed significant improvement in the chest mobility, the Cobb angle and the pulmonary function. While group II showed insignificant decrease in the previous measurements. These results proved that scoliosis affect greatly the pulmonary function through affection of thoracic cage motion and thoracic muscles function. Treatment of scoliosis by physical therapy may be associated with improvement of pulmonary functions and spinal posture.

INTRODUCTION

Scoliosis is defined as a physical deformity not a disease, which means an increase of the lateral curvature of the dorsal spine². The deformity may be structural implying a permanent change in the bones, or soft tissues, or it may be a disturbance produced by postural activity of the spinal muscles¹. Idiopathic scoliosis is the most common spinal deformity. Its reported prevalence rate was about 13.3%. Girls are more likely to be affected than boys⁵. The common clinical features of idiopathic scoliosis are pain, visible deformity, drop of one shoulder, slight protrusion of one scapula,

humping of one side of the back and tilting of pelvis may appear in severe curves¹. Some pulmonary limitations are apparent even in mild curves (21.4 degrees), but curves more than 25 degrees will affect the ventilation more as well as the work capacity as the respiratory muscles expend more energy in breathing⁴. There is a relationship between the scoliotic angle and the aerobic capacity which shows a significant reduction with every 20 degrees increase in the spinal curvature¹⁰. Surgical treatment was recommended for treatment of curves more than 40 degrees¹². Boston brace is widely used in the conservative treatment, but there is a current to limit its use as it may have a negative effect on renal function and

psychological disturbance¹³. Surface electrical stimulation was documented for curves between 20 - 39 degrees⁸. Thus, it is clear now that there is a closed relationship between the scoliotic curves, chest mobility and pulmonary function. The aim of this study was to investigate the changes in lung capacity that accompanied the idiopathic scoliosis and its improvement as a result of postural correction and respiratory muscles training along a three months training program.

MATERIALS AND METHODS

Subjects

Thirty students (13 boys and 17 girls) were chosen randomly from the vertebral column clinic of the Students Health Insurance Hospital in Cairo. Their ages ranged between 12-18 years, the weight ranged between 25-71 kgs and the height ranged between 116-170 cm. All of them had idiopathic scoliosis from 2-4 years and their Cobb angles as measured from their X-rays ranged between 5°-30°. They were divided equally into two groups :- Group I participated in a physical therapy program for five days/week for three successive months. Group II used only the Boston brace for all over the day except for hygiene care for the same duration.

Measurements

Subjects in both groups were subjected to the following examinations before and after termination of the treatment program:-

- 1) Measurement of the scoliotic curves by Cobb' method from the P.A view X-rays (Fig.1).
- 2) Measurement of the chest expansion by a tape measurement at the level of xiphoid process from sitting position and

calculation of the difference between deep inspiration and expiration.

- 3) Measurement of the pulmonary function including the vital capacity (VC), forced vital capacity (FVC), maximum voluntary ventilation (MVV), and respiratory rate (RR), by using Vicatest spirometer from sitting position. The pre and post recorded values were compared and statistically analysed using student't test.

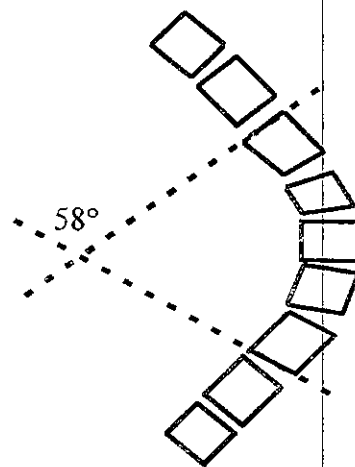


Fig. (1): Shows the measurement of degree of scoliosis by cobb's angle.

Treatment program

The following program was conducted for three months five days/week for group I :-

- 1) Electrical stimulation: from pronelying position, two electrodes were placed on the convex side of paraspinal muscles at the upper and lower borders of the curve. Stimulation intensity was 70 mamp. The duration for stimulation was 30 minutes.
- 2) Therapeutic exercises: included stretching exercises for the paraspinal muscles at the concave side and strengthening exercises for the muscles at the convex side. Each exercise was repeated twenty times per session.

- 3) Localized breathing exercises for the apical, lateral costal, posterior basal and diaphragmatic segments. Each exercise was repeated three successive times followed by rest for two seconds and continued to a total of twenty times / session.

RESULTS

- 1) For group I as shown in table (1) and figures (2,3,4,5):- the mean of Cobb' angle decreased significantly from 23.6 ± 6.06 to 19.52 ± 10.06 degrees.

The the mean of chest expansion increased significantly from 2.06 ± 0.9 to 3.05 ± 1.03 cm. The mean of VC increased significantly from $1.48 \pm 0.5L$ to $1.68 \pm 0.5L$. Also the mean of FVC increased significantly from 1.80 ± 0.62 to $1.98 \pm 0.72L$. The mean of MVV improved significantly from 117.8 ± 20.6 to 123.08 ± 20.03 L/min. The mean of R.R showed slight decrease from 35 ± 4.5 to 31.66 ± 4.7 Br/min.

The percentage of improvement for the previous measures were 12.9%, 48.05%, 13.5%, 10%, 4.5% and 10.5% respectively.

Table (1): The pre and post treatment values of cobb'angle, chest expansion, V.C., FVC, MVV and R.R.of group I.

Variable	Pre-treatment	post-treatment	mean Diff.	level of sig.
	mean \pm SD	mean \pm SD		
Cobb' angle	23.06 ± 6.06	19.52 ± 10.06	3.08	<0.05
Chest expansion	2.06 ± 0.9	3.05 ± 1.03	0.99	<0.05
VC/L	1.48 ± 0.5	1.68 ± 0.5	0.20	<0.05
FVC/L	1.80 ± 0.62	1.98 ± 0.72	0.18	<0.05
MVV L/M	117.8 ± 20.6	123.08 ± 20.03	5.28	<0.05
RR Br/M	35.0 ± 4.5	31.66 ± 4.7	3.34	<0.05

SD. standard deviation
Diff. Difference
sig. Significant

L. Liter
L/M. Liter/minute
Br/M. Breathing/ minute

- (2) For group II as shown in table (2) and figures (2,3,4,5): In this group the mean value of Cobb angle showed insignificant decrease from 25.4 ± 3.85 to $24.3 \pm 3.10^\circ$, which equal 4.5%. The mean value of chest expansion decreased from 2.32 ± 0.65 to 2 ± 0.23 cm which equal 16% i.é, significant reduction. The mean value of VC showed insignificant decrease from 1.5 ± 0.49 to $1.47 \pm 0.49L$, and that of FVC changed from 1.89 ± 0.55 to $1.80 \pm 0.63L$. The percentage of reduction were 2%, 5% respectively. The mean value of MVV showed significant decrease from

115.64 ± 15.43 to $109.2 \pm 24.03L/min$ which equal 5.9% decrease.

The respiratory rate remained the same without change.

- (3) Comparison between the two groups: showed that the mean difference values for all measuring parameters between both groups (I & II) before treatment were statistically non-significant ($P > 0.05$) while as revealed from table (3), the mean difference values of cobb'angle, chest expansion, VC, FVC, MVV, and RR post treatment were statistically significant ($P < 0.05$) in favour of group I.

Table (2): The pre and post treatment values of cobb'angle, chest expansion, V.C., FVC, MVV and R.R. of group II.

Variable	Pre-treatment	post-treatment	mean Diff.	level of sig.
	mean± SD	mean± SD		
Cobb' angle	25.4±3.85	24.3±3.1	1.1	>0.05
Chest expansion	2.32±0.65	2=0.23	0.32	<0.05
VC/L	1.5±0.49	1.47±0.49	0.27	>0.05
FVC/L	1.89±0.55	1.8±0.63	0.09	>0.05
MVV L/M	115.64±15.43	109.2±24.03	6.44	<0.05
RR Br/M	36.65±7.9	36.65±7.9	0	<0.05

SD: standard deviation

L: Liter

Diff: Difference

L/M: Liter/minute

sig: Significant

Br/M: Breathing/ minute

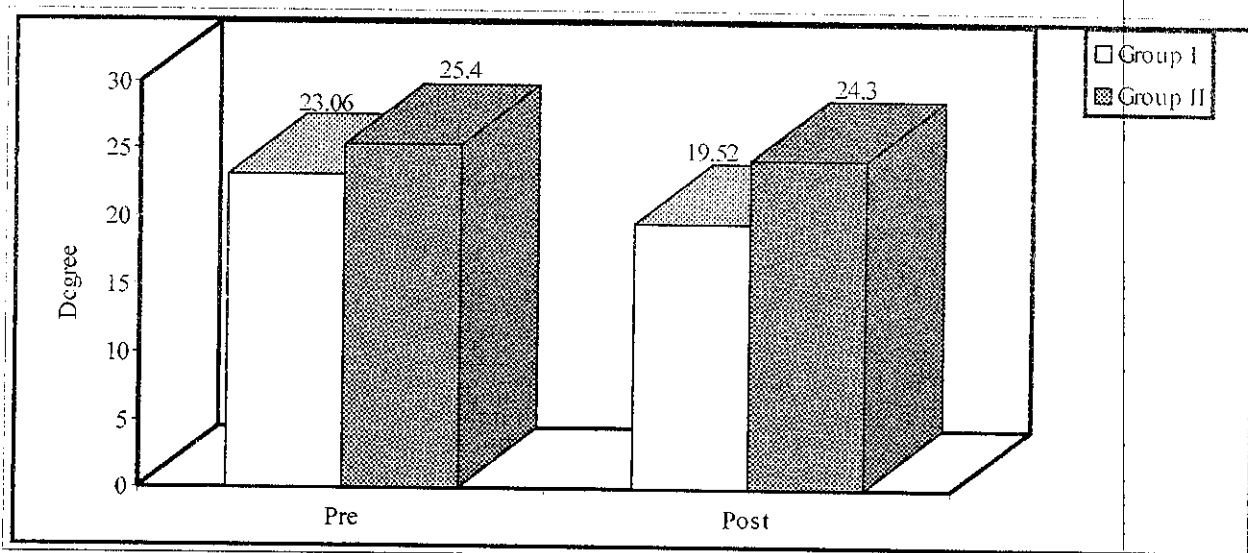


Fig. (2): Comparison between the pre and post treatment values of cobb angle in the both groups.

Table (3): The post treatment values of cobb'angle, chest expansion, V.C., FVC, MVV and R.R. of both groups.

Variable	Group I		Group II		mean Diff.	P value
	mean	± SD	mean	± SD		
Cobb' angle	19.52	10.06	24.3	3.10	4.78	0.02
Chest expansion	3.05	1.03	2	0.23	1.5	0.01
VC	1.68	0.5	1.47	0.49	0.21	0.01
FVC	1.89	0.72	1.8	0.36	0.18	0.02
MVV	123.08	20.03	109.2	24.03	13.88	0.01
RR	31.66	4.7	36.65	7.9	4.99	0.03

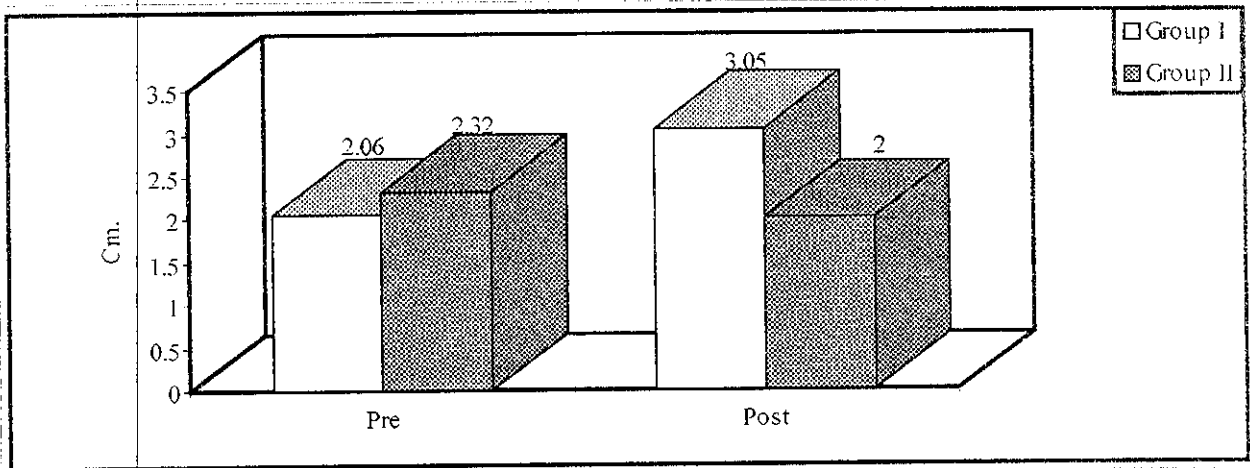


Fig (3): Comparison between the pre and post treatment values of chest expansion of the both groups.

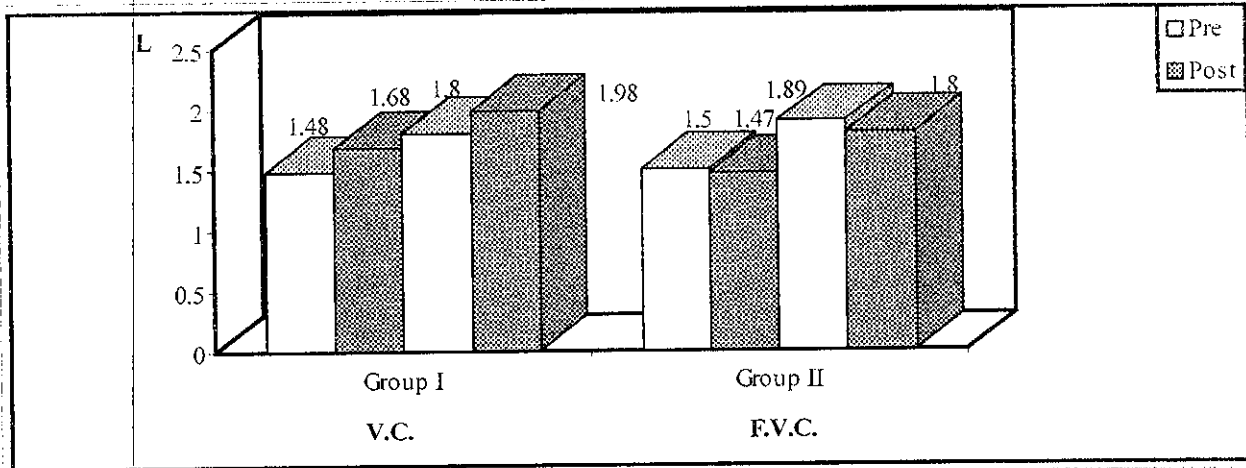


Fig (4): Comparison between the pre and post treatment values of V.C. and F.V.C. in the both groups.

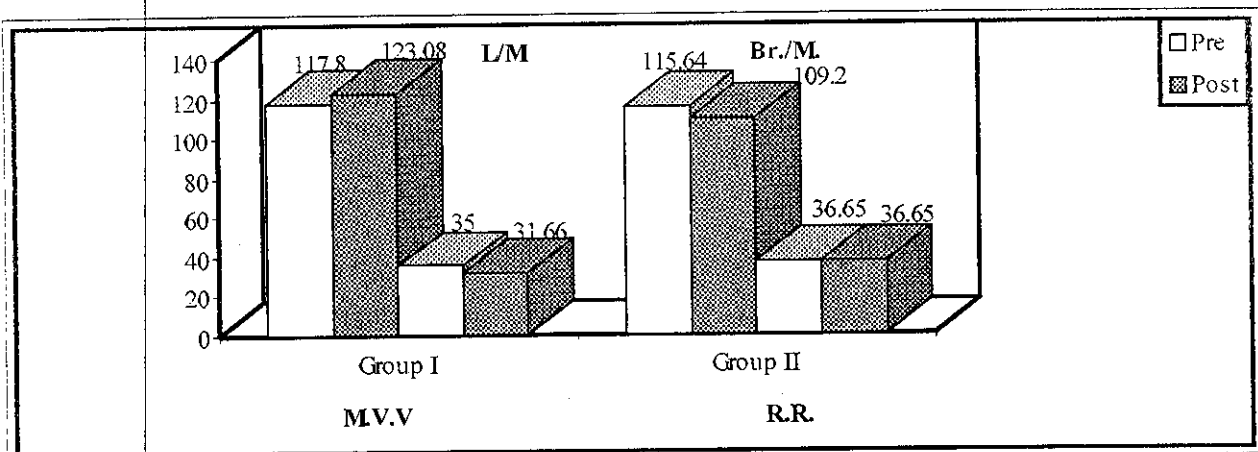


Fig (5): Comparison between the pre and post treatment values of M.V.V. and R.R. in the both groups.

DISCUSSION

The purpose of this study was to test the hypothesis that, pulmonary function and chest expansion can be improved in relation to improvement of scoliotic curve by application of special physical therapy program to those patients with idiopathic scoliosis less than thirty degrees instead of using the current therapy by bracing.

Electrical stimulation has been recommended by many authors, as an alternative to bracing for curves between 20-45°⁷⁻⁹. Therapeutic exercises have been prescribed, in combination with other modalities of physical treatment in order to be effective³. This combination stress active derotation of the spine, maintain of correct alignment and improve muscle strength and chest mobility. It was found that after three months of physical therapy program there was decrease in scoliotic curve which mainly due to stretching of the contracted muscles at the concave side and strengthening of muscles at convex side by both electrical stimulation and exercises, which lead to increase in chest expansion. All these factors together lead to improvement in pulmonary function which was related to improvement in mechanical properties of the lung and chest cage.

This closed interaction between posture and lung function was related to the intercostal muscles function at the lateral chest wall. These muscles are used for respiration but also participate in various postural and locomotor activities when they work to stabilize or to move the rib cage. Mobility of the rib cage as well as its capacity depend mainly on contraction and relaxation of these muscles, which once activated by rotation are strongly inhibited during inspiration as mentioned by Rimmer et-al,¹¹.

They also added that continuous contraction will stimulate their tendon organs and inhibit their inspiratory function. Also our results showed increase in respiratory rate for all subjects with mean 35br/min. This can be explained due to permanent change in respiratory pattern as a result of the load produced by the bending deformity. So the respiratory muscle tend to readapt to this new situation to increase its endurance and force.

These changes in breathing pattern as mentioned by Eastwood et al.,⁵ included decrease in inspiratory time and hence decrease in tidal volume which lead to shallow rapid breathing. This consider an important problem to those patients and will affect their endurance capacity, so must be controlled and corrected as early as possible. The result were coincident with previous study by Kesten et al.,⁷ which found reduction in vital capacity and exercises tolerance in idiopathic scoliotic adults.

All these results have been proved by Dirocco & Paul⁴, the attributed the reduction in total lung volumes and VC in those patients to the rigidity of the bony framework leaving the diaphragm working alone.

CONCLUSION

It can be said that improvement of pulmonary function in idiopathic scoliosis was closely related to improvement in the dorsal curve, application of a physical therapy program which deal with both posture deformity as well as the respiratory pattern. Bracing must be limited to curves more than 40 degrees as it may cause negative effect on the pulmonary function, respiratory rate, chest mobility and its bad psychological effect. Therapeutic exercises are the most convenient, least expensive and readily

available form of the current non-operative treatment for the mangment of idiopathic scoliosis. Localized breathing exercises must be applied to all lung segements to reduce the plumonary complications of such patients and control their respiratory rate.

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مقارنة بين برنامج العلاج الطبيعي المختار والدعامات على وظائف الرئة في حالات انحناء العمود الفقري البسيطة

هدف البحث : هو دراسة تأثير انحناء العمود الفقري على وظائف الرئة وفاعلية العلاج الطبيعي مقابل الدعامات . اشترك في البحث (٢٠ بنت وولد) تراوحت أعمارهم بين ١٢ - ١٨ سنة وتراوحت درجة انحناء العمود الفقري بين ٥ - ٣٠ درجة . وقد تم تقسيمهم عشوائياً إلى مجموعتين متساويتين في العدد .

وشمل برنامج العلاج لمجموعة الأولى على تمارينات علاجية لعضلات الظهر وتمارينات تنفس وتنبيه للعضلات في الجانب المحلب بينما اقتصر العلاج للمجموعة الثانية على استخدام الحزام السائد للفرات الصدرية فقط . استمر العلاج للمجموعتين لمدة ثلاث شهور متتالية تم التقييم للمجموعتين قبل وبعد العلاج واشتمل على قياس درجة الانحناء من الأشعة الأمامية - قياس مدى الحركة لاتساع القفص الصدري وقياس سعة الرئة .

هذا وقد أظهرت النتائج تحسن واضح في درجة الانحناء للمجموعة الأولى بينما زيادة طفيفة للمجموعة الثانية . كما تحسنت مدى الحركة بالنسبة للمجموعة الأولى تحسن ملحوظ على عكس المجموعة الثانية . أما بالنسبة لوظائف الرئة فالتحسن كان واضح للمجموعة الأولى ونقصت بالنسبة للمجموعة الثانية وهكذا فقد أثبتت هذه النتائج أن انحناء العمود الفقري يؤثر على وظائف الرئة وأن علاج هذا الانحناء بالعلاج الطبيعي يكون مصاحب لتحسن في وظائف الرئة مع تحسن القوام .