Original Research

Integrative Treatment Using Chiropractic and Conventional Techniques for Adolescent Idiopathic Scoliosis: Outcomes in Four Patients

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ABSTRACT

Background: Bracing treatment for adolescent idiopathic scoliosis is a commonly prescribed treatment for curvatures up to roughly 35°. Little data in the United States has been published concerning bracing treatment for larger curves, as surgical intervention is typically reserved for such cases. This study reports on the combined use of Boston bracing and a conservative manual therapy system for larger magnitude scoliosis.

Methods: A total of 4 patients presented to a private spine clinic for treatment consisting of bracing, a patented weighting system, vibration therapy, and manual traction procedures. The evaluation process consisted of multiple outcomes, including radiographic, functional, respiratory, and postural assessments. Patients were evaluated at the onset of treatment and after 90 days.

Results: All 4 patients saw their major curvatures reduced an average of 13.5°. Peak expiratory flow, computerized postural assessment, chest expansion, rib hump measurements, and functional rating index scores also improved for all patients. Two of the patients also reported an improvement in specific symptoms.

Conclusion: Using this combined treatment for 90 days, the patients outlined here were able to achieve positive benefits in radiographic, functional, and physiological outcome measures. Limited conclusions can be made due to the study design, however. All patients will be monitored for moderate and long-term assessments.

Key Words: *Chiropractic, Scoliosis, Vertebral Subluxation, Bracing, Pettibon Technique*

Background

Although idiopathic scoliosis is typically characterized as an orthopedic deformity, its health consequences extend well beyond the musculoskeletal system. A 50-year natural history study by Weinstein et al[1] suggests that people with untreated scoliosis have "little physical impairment other than back pain and cosmetic concerns." However, it is also known that even mild spinal curvatures beginning at 10º are associated with reduced chest wall compliance and vital capacity,[2] reduced exercise capacity,[3-5] recurrent respiratory infection,[6,7] reduced spinal flexibility,[2] recurrent back pain,[8,9] psychological distress,[10,11] and cardiac or respiratory failure for curvatures greater than 70º.[12,13] Therefore, any curvature beyond 10º should be treated to minimize or prevent these symptoms.

In the United States, the Boston brace is one of the more commonly used orthoses for the treatment of scoliosis. This may be due to the extensive published data pertaining to both its short and long-term outcomes. An earlier study by Emans et al[14] evaluated the results of 295 patients (mean age of 13.2 years) using the Boston brace for an average period of 2.9 years. They found an average best in-brace correction of 50%, with a mean 15% correction after treatment and 11% mean correction at 1.4 years follow-up. All patients in this study have curvatures between 20-59º.

The Boston brace may also have increased effectiveness compared to other bracing systems. When compared to the Charleston Nighttime Bending brace, the Boston brace demonstrated more effectiveness in preventing curvature progression and reducing the incidence of surgical intervention.[15] More specifically, 43% of patients using the

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Boston brace experienced curvature progression greater than 5º, versus 83% of patients using the Charleston brace. The Wilmington brace has shown effectiveness in reducing the amount of spinal decompensation in 70% of 372 scoliosis patients with curvature magnitudes of 20-49°.[16]

Spinal decompensation is defined as the horizontal distance between the vertical axes of the sacrum and occiput. This distance should be less than 1cm, according to Rudicel and Renshaw.[17] A later study by Allington and Richard[18] showed that full-time and part time bracing in 188 patients produced similar reductions in curvature progression ($p < 0.18$). These patients had curvatures up to 40°.[18] The Milwaukee brace performed in a similar fashion to the Wilmington brace. In a review of 1020 radiographs by Lonstein and Winter,[19] the Milwaukee brace demonstrated a failure rate of 23%. Failure rate was defined as an increase in the curvature of more than 5°.[19] A newer, dynamic brace, called a SpineCor, has recently been reported. A study by Coillard et al[20] followed a group of 195 patients treated with idiopathic scoliosis using the SpineCor brace. The patients were divided into two groups: those with curvatures above 30° and those below 30°. A total of 29 patients were followed up after 2 years (avg. Cobb angle of 30° ± 9). This group showed a 90-day mean Cobb angle reduction of 10° ± 5, with a 2-yr follow-up of 5°.[20] However, the highest Cobb angle in the sample group was 41°. A larger cohort of 365 patients using the SpineCor brace were followed for 5 years post-treatment, showing that 65.4% of these patients achieved a permanent correction, while only 3.8% had worsened. Again, while this is good evidence of correction, the mean curvature magnitude did not exceed 40°.[21]

Although bracing has shown good clinical success, it does have specific limitations. Katz and Durrani[22] performed a retrospective analysis of 51 patients treated with the Boston brace for curvatures ranging from 36-45º. They found that 31 of these patients were considered successes, while 16 patients eventually required surgical intervention. There is little available research that investigates bracing treatment at curvatures higher than 45º. According to standardized criteria outlined by the Scoliosis Research Society,[23] optimal bracing candidates share the following characteristics: ≥ 10 years of age, Risser sign of 0-2, primary curvature of 25-40°, and premenarchial to < 1 year postmenarchial if female.

Scoliosis treatment using the Pettibon System has previously been reported.[24-26] However, in all these reported cases, only one of 23 total cases presented with an initial Cobb angle above 40º (52º).[24] Here we report 4 cases of adolescent idiopathic scoliosis with moderate and severe curvatures, ranging from 42°-89°. This report is a more extensive version of a case report presented at the 3rd Annual International Conference on Conservative Management of Spinal Deformities (www.sosort.org).[27] These patients were treated using a combination of the Pettibon System and Boston bracing. Their multi-factorial, collective outcomes after 90 days of treatment are reported.

Four patients reported to the Grand Blanc Spine Center in Grand Blanc, MI USA for scoliosis treatment. All 4 patients were female, ages 12,12,13, and 14. Prior to manuscript preparation, the center's HIPAA compliance officer obtained written permission from the patients' parents to report age, gender, and treatment outcomes. Before beginning active treatment, patients were fitted for a Boston thoraco-lumbo-sacral orthosis (TLSO) brace. The patients then presented to their initial visit with their respective brace and were evaluated for treatment development. Radiographs of each patient while wearing their brace were taken prior to manual therapy being rendered. Patients were evaluated using functional, radiographic, and physiological outcomes. Specifically, peak expiratory flow, computerized posture analysis, chest expansion, Cobb measurements, the functional rating index, and rib hump measurements were recorded. Each patient was tested before being accepted for treatment. Under the protocol taught in the Pettibon System,[28] patients are first tested to predict whether or not they will respond to this treatment method. If they don't, they are not accepted for care and are referred to the most appropriate provider. Examples of this testing procedure have been previously published.[29,30]

This initial testing for scoliosis patients involves routine warm-up stretches, autotraction, spinal manipulation, vibration traction, posture corrective exercise, and post-treatment x-rays were performed while wearing the brace and an external weighting system simultaneously. The warm-up stretches and autotraction are shown in **Figure 1**. Chiropractic adjustments were employed for the purpose of mobilizing spinal joints so that the following rehabilitative exercises are performed while the joints have a temporary increase in mobility.

The vibration traction, shown in **Figure 2**, was performed using a Pettibon Wobble Chair, a Soloflex variable-speed motor, and a NeckPro traction system. For this procedure, the patient puts on his/her individually prescribed weighting system, which may include bilateral hipweights and a shoulderweight, followed by the Boston brace. The patient is then helped into the traction unit, and the right amount of tension is applied. In order to find the right tension, the patient is instructed to pull the rope until the neck feels stretched, but the neck muscles are not activating. As the patient pulls the rope, a series of clicks are heard. Each click increases the traction force by approximately one pound. The vibration motor is turned on and set for 45 Hz frequency, and the patient performs this exercise for 20 minutes. At 5-minute intervals, the patient is instructed to pull the rope one or two more clicks. Following this 20-minute session, the patient is instructed to take off the weighting system, after which the straps on the posterior of the brace are pulled tighter. An illustration of this can be seen in **Figure 2**. The patient then adds the entire weighting system, and an anteroposterior radiograph is taken to calculate in-brace correction. In these 4 cases, in-brace corrections met or exceeded 25%, with a high of 58%. A sample of this radiographic process is shown in **Figure 3**. Each patient was then prescribed a specific course of treatment for 90 days. Post-treatment x-rays were taken an average of 37 hours following the previous clinic visit.

Results

After 90 days of care, all patients were re-examined. Post-treatment anteroposterior radiographs, peak expiratory flow, a functional rating index, computerized posture analysis using PosturePro software (www.posturepro.com), chest expansion, and rib hump measurements using a scoliometer were obtained. A physician independent from this study, to avoid

examiner bias, analyzed all pre- and post-treatment radiographs. The collective results of the four patients are shown in **Table 1**.

Patient 1 initially presented with an 89° thoracic dextroscoliosis and a 32° left levoscoliosis. The thoracic curvature was reduced to 77°, while the lumbar scoliosis remained at 32°. Her peak expiratory flow increased 11%, chest expansion increased from.75" to 1.6", her rib hump decreased 5° at the T8 vertebral level, while her posture improved 34%. Her functional rating index remained at a 4/40, and she reported a complete resolution in her daily chest pain and heart palpitations.

Patient 2 began treatment with a 63° right thoracolumbar scoliosis. At re-examination, her peak expiratory flow increased 29%, chest expansion increased from .75" to 3.25", rib hump with T8 apex reduced 7°, and her posture improved 51%. Her functional rating index decreased from 5/40 to 1/40, while her scoliosis decreased to 44°. She did not report any symptoms throughout the 90-day treatment period.

Patient 3 started her care with an 83° thoracolumbar scoliosis. Following care, chest expansion increased from .25" to 1.25", rib hump reduced 3°, peak expiratory flow increased 27%, posture improved 22%, her functional rating index reduced from 12/40 to 7/40. Her curvature decreased to 73°. She also did not report any subjective complaints throughout care.

Finally, patient 4 reported initially with a right thoracic scoliosis of 42°, which reduced to 29° at re-evaluation. Her functional rating index reduced from 2/40 to 0/40, chest expansion increased from 1.0" to 1.5", her posture improved 33%, peak expiratory flow increased 17%, and her rib hump reduced 4°.

Discussion

In all cases, an initial in-brace correction of 25% or greater was achieved. This finding is consistent with the observation by Katz and Durrani[3] that an in-brace correction of at least 25% significantly increases the likelihood of success with bracing treatment. However, they also identify >18 hours of brace use per day as a significant predictor of success. Here, our patients were instructed to wear their braces only 6-10 hours per day. Previous studies report an average compliance rate of 67.5% to 75% when full-time bracing is prescribed.[31,32] Therefore, it is possible that these four patients did not wear their brace for the entire 6-10 hours per day. All home care and bracing could be performed in their own home. This may also reduce the negative impact of bracing treatment on psychological well being.[33,34] We hypothesize that this may increase compliance, since the patients did not have to wear their braces to school. Although pulmonary restriction has been a reported concern,[35] Korovessis[36] found no detrimental effects of brace treatment on pulmonary function over a 2-year period.

Studies of scoliosis patients have indicated that the long-term health of the spine may be more related to the sagittal profile rather than frontal alignment.[37,38] Additionally, abnormal sagittal alignment has also been associated with an increased risk of frontal Cobb angle progression.[39] This observation forms the basis for the hypothesis that complementing the bracing treatment with the Pettibon System may provide a more complete treatment outcome. The Pettibon System places a clinical priority on restoring sagittal alignment,[28] especially in patients with scoliosis.[24-26] Typically, bracing treatment lasts about 2-3 years, or shortly after the onset of menarche. However, in cases where the scoliotic curvature is not completely corrected, asymmetric spinal loading will still cause the curvature to progress over the remainder of the patient's lifetime,[40, 41] even in cases of surgically-treated scoliosis.[42,43,44] Therefore, if patients continue to perform rehabilitative procedures, designed to promote sagittal alignment, after discontinuance of the bracing treatment, the effects of the brace treatment may be maximized. This will be the focus of future articles pertaining to the combination of these treatments.

Traditionally, outcomes for scoliosis treatment have included self-rated health assessment questionnaires, such as the SF-36, and Cobb angle measurements taken from full-spine radiographs. In our report, we decided to also outline the physiological improvements achieved following 90 days of this combined treatment regimen. These types of physiological parameters are indeed important outcome goals, according to a recent consensus opinion of physicians and therapists.[45,46]

It is important to note that the data illustrated in this study is over a relatively short time frame. Because of that, it is unknown what the intermediate and long-term effects of this treatment are, especially since a curvature still remains in all 4 cases, which perpetuates asymmetric loading, growth, and ultimately remodeling. Other factors, such as remaining growth, compliance, and co-morbidities must be accounted for. Achievement of results at 90 days does not guarantee maintenance of results, especially if these others factors are present. Consistent treatment must be maintained as long as asymmetric gravitational loading exceeds spinal muscle strength and endurance.[40] Constant maintenance must be performed in a life-long disorder such as scoliosis.[47]

Conclusion

Four cases of moderate to severe adolescent idiopathic scoliosis achieved positive radiographic, respiratory, functional, and symptomatic improvements following a 90-day course of integrative scoliosis treatment using the Boston brace and the Pettibon System. Integrative treatments such as this may provide chiropractors with an opportunity for interprofessional dialogue and cooperative management from traditional providers. It is unknown how these improvements are related to the treatment procedures. The present study design limits any firm conclusions. Any proposed scoliosis treatment should consider using physiological outcome assessments, since scoliosis is associated with a variety of non-musculoskeletal disorders.

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Competing Interests

MWM is the director of research for the Pettibon Institute. He is not financially compensated for his position. However, he does receive funding for statistician services, and is compensated by the institute as a postgraduate instructor.

Table 1														
Patient	Age	Risser	Cobb 1	Cobb 2	PEF 1	PEF 2	RH 1	RH 2	CE 1	CE 2	Posture 1	Posture 2	FRI 1	FRI 2
					(L/min)	(L/min)					N=0-5	N=0-5	x/40	x/40
1	**12**	**1**	**89/32**	**77/32**	**340**	**390**	**20**	**15**	**0.8**	**1.6**	**35**	**23**	**4**	**4**
2	**14**	**4**	**63**	**44**	**210**	**270**	**18**	**11**	**0.8**	**3.3**	**35**	**17**	**5**	**1**
3	**13**	**4**	**83**	**73**	**310**	**390**	**21**	**16**	**0.3**	**1.3**	**24**	**19**	**12**	**7**
4	**12**	**2**	**42**	**29**	**290**	**340**	**12**	**8**	**1**	**1.5**	**18**	**12**	**2**	**0**

"1" represents initial findings; "2" represents 90-day findings
Cobb = radiographic Cobb angle in degrees
PEF = Peak Expiratory Flow
RH = Rib Hump measurement in degrees
CE = Chest Expansion or Rib Cage Expansion in inches
Posture = Posture Rating Score on PosturePro software; normal = 0-5
FRI = Functional Rating Index score; score/40 = % disability

Figure 1

The wobble chair exercises and the auto-traction performed over a door.

Figure 2

The picture on the left illustrates the vibration traction therapy for 20 minutes per visit. Following this, the patient's brace was tightened, and worn that way for the remainder of the day.

Figure 3

This figure provides a sample illustration of the radiographic testing process used in these cases. The radiograph on the left is the initial view, the middle radiograph was taken prior to treatment intervention wearing the brace only. The right radiograph was taken following the treatment intervention, using the tightened brace and weighting system combined. This is patient #4.