Case Series

Changes in clinical and radiographic parameters after a two-week regimen of chiropractic manipulation combined with soft tissue therapy and neuromuscular rehabilitation in 7 adult idiopathic scoliosis patients

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Background

The term Adult Idiopathic Scoliosis (Adult IS) is used to describe any lateral spinal curvature of unknown origin in a person greater than 18 years of age. Some cases may arise in childhood or adolescence and go undiagnosed; others may develop spontaneously.[1]

The prevalence of scoliosis seems to increase with age. Compared to 2-4% of adolescents,[2] scoliosis was reported in 12-15% of college students.[3,4] Scoliosis was found in 8.85% of adults over 40; in 19.9% of 1,299 adults with low-back pain; and, in 68% of healthy adults over 60.[5-7]

Although the majority of curvatures progress in adulthood, the rate generally slows and seldom increases as quickly as in early adolescence. Spontaneous regression of adult IS is extremely rare, if it exists. In a review of 587 cases of adult spinal deformity followed without treatment for up to 50 years, no case was reported to improve spontaneously (see Table 1.1).[8]

The risk factors for progression of adult IS are Harrington Factor, Disc Index, and curve type.[9,10] Curves greater than 30 degrees at the cessation of growth are more likely to progress in adulthood.[11]

Adolescents with idiopathic scoliosis may have impaired cardiopulmonary function upon exertion[12,13], increased risk of pain[14,15], and psychosocial disabilities related to their condition.[16-18] An adult with idiopathic scoliosis is subject to the after-effects of living with these aforementioned symptoms in adolescence, and may have increased risk of pain, lower perception of their quality of life, and decreased social and emotional health.[19,20] Severe scoliosis in adults is often accompanied by cardiopulmonary compromise.[21-23]

Adult IS is generally regarded as undeserving of treatment unless merited by pain, cosmetic reasons, pulmonary problems, and/or progression.[24] Bracing is traditionally recommended only for skeletally immature patients; surgery is the sole recommended treatment for adults. Regarding conservative care, according to Everett *et al*, "*the available literature is supportive of further clinical research in conservative care as a treatment in adult deformity."*[25] It is possible that one of the barriers in undertaking this research is a long-held belief that spinal deformity, in an adult, is permanent and cannot be changed except through surgery. It has been known since 1969 that scoliosis can continue to progress after skeletal maturity,[26] with more rapid progression linked to greater sagittal and coronal spinal imbalances.[25,27] If the adult scoliotic spine can progress in the presence of imbalanced forces, it may be possible that progression can be prevented or reversed if spinal imbalances are corrected. Previous case reports are suggestive of this possibility.[28-32]

We present a review of files chronicling the results of a novel two-week regimen of chiropractic manipulation combined with soft tissue therapy and neuromuscular rehabilitation in 7 patients with adult idiopathic scoliosis.

Methods (Case presentation)

Patient population

The authors conducted a retrospective review of 7 consecutive case files of patients with adult idiopathic scoliosis who self-selected this treatment method and presented for care between 1-

1-2011 to 1-1-2012 at a private chiropractic practice in Dallas, Texas. The inclusion criteria for adult idiopathic scoliosis were defined as follows: previous orthopedic diagnosis of adolescent idiopathic scoliosis in an individual with a current chronological age greater than 18 and radiographic evidence of skeletal maturity (completed Risser sign). All patients were negative for malignancy, fractures, arthrodesis, degenerative changes suggestive of *de novo* scoliosis, and neurological or congenital defects (including anatomical leg length inequality).

There were 2 males and 5 females, median age 29 years (range 23 to 61). Four patients presented with double thoracic and lumbar (“S”) curves; two presented with a single thoracolumbar (“C”) curve, and one presented with a single lumbar curve. The mean Cobb angle was 46.4 (range 36 – 56.5) thoracic and 37.7 (range 9 - 60) lumbar. Family history for scoliosis was positive in 3 individuals. All of the cases were diagnosed in adolescence. Written informed consent to treatment, radiographic procedures, and the use of data for research purposes was obtained from each patient. File numbers were changed to protect the identities of each patient.

Clinical and radiological outcomes

Standards of care and physical examinations were performed on all patients. Clinical outcome assessment measures included digital spirometry;[33,34] scoliometry in Adam’s position at T6, T12, and L3;[35] timed one-legged stability with eyes closed (TOLSWEC);[36] and, computerized dual inclinometry. Radiographic measures included Cobb angle, vertebral rotation,[37,38] and apical vertebral deviation.[39] Questionnaires included VAS pain scale, RAND SF-36 and SRS-22.[40]

Procedure

Each patient underwent twenty treatment sessions over a two week period (2 times daily/ten days) for an average length of 180 minutes/session.

Treatment sessions were in three phases. The first phase consisted of six parts: active spinal mobility exercises, passive vibration therapy, active cervical traction exercises, massage therapy, passive spinal distraction therapy, and mobilization therapy.

The second phase consisted of CMT. Supine thoracic, prone lumbar, side-posture pelvic manual manipulations, and seated cervical instrument-assisted manipulations (ArthroStim^{TM} – Impac, Inc.) were performed.

The third phase consisted of three parts: reactive body weighting therapy, isometric spinal exercises, and whole-body vibration therapy.

Patients were instructed to perform at-home exercises and therapies to correlate with their particular case. Each patient was provided with equipment: a cervical traction device, foam rolls and wedges, an air-filled balance training disc, weighted headbands and belts, and a weighted cantilever. Patients were also advised to obtain a Scoliosis Traction Chair (Vibe For Health^{TM} - Madison Lake, MN) for use at home. The patients were instructed to perform home rehabilitation procedures twice daily, with each session lasting between 30 and 60 minutes, for a total of 60 to 120 minutes of daily home exercises. This exercise routine is reduced by approximately half in patients who exhibit generally positive results at 6-month follow-up.

Follow-up was initiated at least one year after the conclusion of the 2-week treatment period. Patients were contacted for follow-up via mail, e-mail, and telephone from December 2012 to March 2013, and asked to provide two health-related quality-of-life questionnaires (RAND SF-36 and SRS-22) to be filled out by the patient, and a standard scoliosis x-ray taken at an appropriate location and sent to the primary author for analysis.

Results

The average Cobb angle change was -9 degrees. Rotation of the apical vertebra decreased by an average of 3%. Deviation of the apical vertebra from the intercrestal line decreased by an average of 8 mm. Spirometric indices demonstrated median improvements of 50 cc's in forced vital capacity improvement, 2% in forced expiratory rate, 700 cc's in peak expiratory flow, and 20 cc's in forced expiratory volume in one second. Scoliometer readings decreased by an average of 3.5 degrees. Timed one-legged stability improved by an average of 10.7 seconds. The most dramatic improvements in average spinal ranges of motion occurred in right lateral cervical flexion (8.7 degrees), right thoracic rotation (6.9 degrees), and left lateral cervical flexion (5.1 degrees). An average decrease of 8.7 degrees was noted in left lateral cervical flexion.

Three patients did not respond to requests for follow-up data; three patients completed the SRS-22, four patients completed the RAND SF-36, and one patient provided a follow-up radiograph. The mean score for the SRS-22 was 4.45, with satisfaction with their back management rated at 4.83 (out of 5). The mean score for the RAND SF-36 was 68% pre-treatment and 80% post-treatment. The follow-up radiograph demonstrated a sustained change of -6 degrees in the cervicodorsal Cobb angle, stabilization of the thoracic Cobb angle and sustained improvement in the apical vertebral rotation, and a +3 degree change in the lumbar Cobb angle.

Discussion

The goals of this therapeutic intervention were two-fold. One goal was to address neuromuscular function, and another was to influence the biomechanical factors which may encourage curve progression.

Proprioceptive deficits and issues with balance have been reported to occur in scoliosis.[41,42] A dysponesis between the sensory input and motor feedback systems (Central Pattern Generators and Proprioceptive Mismatch Correctors, or CPG's and PMC's) of the body could drive a neuromuscular imbalance that could lead to failures in the rotation-control systems; symmetrical function of neuromuscular mechanisms has been shown to be necessary for ideal spinal alignment.[43-45] The hypothesis that vestibular asymmetry plays a role in the etiology of scoliosis has been supported in an animal model.[46] However, treatment designed to affect the neuromuscular factors involved in scoliosis has not been specifically investigated. Improving proprioceptive function could have benefit in reducing the risk factors involved in progression of scoliosis.[47,48] This protocol utilized repeated exercise, whole-body vibration therapy, and gait therapy to influence neuromuscular function.[49-52] This was combined with reactive body weighting (balance training exercises), in which the patient reacted to strategically positioned weights and cantilevers on the body while standing on an unstable surface, to rehabilitate the postural correction mechanisms. Changes were measured with the TOLSWEC test, with 6 of 7 patients demonstrating a mean increase in timed stability of 10.8 seconds.

The 3-dimensional involvement of the spine in scoliosis is generally accepted; what remains controversial is its role as a primary factor in the etiology of scoliosis.[53,54] Neuromuscular factors have been suggested to contribute to the etiology of scoliosis, and biomechanical factors to its progression.[55] Spinal imbalances and disruptions in the sagittal (and axial) plane have the capability of producing biomechanical imbalances which can influence curve progression in the coronal plane.[56-64] Loss of the sagittal curves, resulting in a straightening of the spine, has been reported to contribute to scoliosis progression.[65] Vertebral wedging occurs in scoliosis not only in the coronal plane, but in the sagittal dimension as well.[66] The possibility of preventing scoliosis through treatment aimed at sagittal correction has been previously suggested.[67] The applied protocol utilized a system of three-dimensional x-ray analysis to determine the applied CMT, with the goal of influencing spinal biomechanics and restoring optimal sagittal alignment.

According to a recent consensus of specialists in the conservative treatment of scoliosis, quality of life and cosmesis (personal appearance) were ranked as the two most important factors in scoliosis care.[68] Radiographic measures alone are insufficient to determine the effect of scoliosis upon an individual's quality of life; for this reason, functional outcome measures, such as spirometry and scoliometry, were included. Long-term pulmonary impairment is one of the leading causes of disability in scoliosis.[69] While only 1 of the patients in this study had spirometry readings below the predicted value (according to the reference values from

Hankinson 1999),[70] four were at the lower limits of normal; improvements in at least one of the four spirometric parameters were noted in every patient.

Aesthetics (cosmetic appearance) is not only important in the adolescent population but the adult population as well. In fact, older patients may perceive their deformities as more severe than their younger counterparts.[71] More severe cosmetic deformities are associated with lower health-related quality of life scores, and have a negative correlation with physical and psychological function.[19,72] Many patients seek care due to concerns regarding their appearance rather than the underlying spinal deformity, and changes in radiographic indices do not always correlate with changes in cosmesis.[72] For this reason, cosmesis was specifically investigated and quantified through scoliometry; improvements were noted in every patient in at least two of the three vertebral levels assessed.

Conclusion

Case studies on adult idiopathic scoliosis patients offer an advantage over similar studies on adolescent populations, as spontaneous regression has never been documented to occur in an adult idiopathic scoliosis patient. While this study was a retrospective observational review lacking a control group, allowing no extrapolation beyond the involved subjects, the results support the premise that spinal deformity in adults is NOT unalterable.

When treatment is indicated for adult scoliosis, the only currently-recognized orthopedic treatment option is surgery. The results of this study add to the current body of case reports that indicate the need for further research into alternative methods.

Future studies could utilize a pragmatic design comparing the 2-years post-treatment results of surgical intervention to the 2-year post-treatment results of a similar adolescent or adult population undergoing an alternative treatment protocol (such as the one described in this article) to evaluate their comparative efficiency in a real-world scenario.

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Table 1.1 - Incidence of Curvature Progression: After skeletal maturity[8]

Study	# of Scoliosis Cases	Initial Cobb angle	Incidence of Progression
Ascani et al., 1986	187	<20 - >60	100%
Bjerkrein and Hassan., 1982	70	10-154	60%
Collis and Ponseti., 1968	134	<50 - >100	69%
Korovessis et al., 1994	91	>10	67%
Weinstein and Ponseti., 1983	102	15-135	68%
Totals and Averages	**584**	**10 – 154**	**72.8%**

Table 2.1 – Clinical and radiographic outcome measures, pre and post treatment

	Radiographic Indices					
	Thoracic Cobb (°)	*Thoracic Rotation (%)*	*Thoracic Deviation (mm)*	*Lumbar Cobb (°)*	*Lumbar Rotation (%)*	*Lumbar Deviation (mm)*
Δ Mean	-9.92	-3.33	-7.83	-9.33	-2.73	-4.42
Δ Median	-9.25	-2.65	-4.5	-8	-1.1	-5.75
Δ Min	-4	0	-1	-1	-0.6	-11
Δ Max	-15	-11	-12	-21	-5.1	-11.5

	Spirometric Indices				**Timed One-Legged Stability with Eyes Closed**	
	FVC (cc)	*FER (%)*	*PEF (cc)*	*FEV1 (cc)*	*Left*	*Right*
Δ Mean	-78.57	2.14%	540	42.86	10.14	11.43
Δ Median	50	2%	700	20	23	19
Δ Min	-180	-13%	-1470	-270	0	8
Δ Max	490	2%	-100	120	25	22

	Spinal Ranges of Motion (°)					
	Cervical Flexion	*Cervical Extension*	*Left Lateral Cervical Flexion*	*Right Lateral Cervical Flexion*	*Left Cervical Rotation*	*Right Cervical Rotation*
Δ Mean	-8.86	1.71	5.14	8.71	-3.86	3.29
Δ Median	-9	8	12	1	-13	2
Δ Min	-6	-19	-16	-20	-12	-20
Δ Max	23	23	9	14	15	19

	Spinal Ranges of Motion (continued)				**Scoliometry** (°)		
	Left Thoracic Rotation	*Right Thoracic Rotation*	*Left Lateral Lumbar Flexion*	*Right Lateral Lumbar Flexion*	*T6*	*T12*	*L3*
Δ Mean	2.86	6.86	-3.86	8.43	-3.43	-3.71	-3.43
Δ Median	0	6	-9	16	-5	0	-3
Δ Min	-18	-23	-18	-26	0	0	-2
Δ Max	9	8	23	13	-8	-10	-7