Changes in Gait Parameter with Adolescent Idiopatic Scoliosis

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Purpose: The purpose of this study will demonstrate that relationship between scoliosis and gait factor and foot weight bearing in ambulation.

Methods: Subjects were 40 elementary students. A normal control group consisted of a total of 20 children without any known musculoskeletal disorders and an AIS group of 20 children with mild AIS (defined by a Cobb angle between 10 and 25°) were recruited. Measurements were scoliometer screening test, Cobb angle, gait parameter (rate of swing/stance phase, gait velosity), foot weight bearing (entire, fore, hind).

Results: Scoliometer screening test (P = 0.000) and X-ray Cobb angle (P = 0.000) significant difference of group which was significantly higher in the AIS group. Gait parameter not showed significant difference. Forefoot weight bearing was significantly higher in the AIS group than more normal group.

Conclusion: It seems that the results of weight bearing analysis in ambulation may be used in modifying rehabilitation programs for individual needs of patients with idiopathic scoliosis.

Key Words: Adolescent idiopatic scoliosis (AIS), Gait, Weight bearing

I. Introduction

Scoliosis, simply defined as a lateral curvature of the spine, has been recognized clinically for centuries.[1] Idiopathic scoliosis has been divided into infantile idiopathic scoliosis (IIS), juvenile idiopathic scoliosis (JIS), adolescent idiopathic scoliosis (AIS). Advanced research into the early onset types of scoliosis (IIS and JIS) have pointed out that about twenty percent of these patients have neuro-axis anomalies which may contribute to the development of a curved spine.[2] These types of urves in all patients under ten years of age may not actually be "idiopathic" in nature. For this reason, the natural history of these patients is different from the behavior of late onset scoliosis (AIS).[3] Idiopathic scoliosis is a chronic health condition often diagnosed in late childhood and early adolescence. This condition is distinguished by two features: lateral growth of the spine (at least ten degrees) and rotation of its vertebrae.[4] The prevalence rate of adolescent idiopathic scoliosis, using a cut-off point of 10° Cobb or more, is approximately 2% to 2.5%.[5] Prevalence as high as 9.2% has been reported: although only 0.23% required treatment.[6]

Scoliosis is a common and relatively slowly evolving condition. Scoliosis in children tends to present as a cosmetic problem, whereas scoliosis in adults more often presents with pain and neurological symptoms. Deformity of the axial skeleton may have a bearing on other musculoskeletal problems in the upper or lower limb and

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vice versa.[7]

Furthermore , considering the effect of scoliosis progression on gait parameters, two previous studies, performed on scoliosis patients before any treatment, have shown that the scoliosis deformity generated changes in gait parameters compared with healthy subjects. These changes included a reduction of the frontal pelvic, hip, and shoulder motion; a decrease in muscular mechanical work.[8,9]

Scoliosis was kinematic changes also included decreased hip and knee ranges of motion in the sagittal plane, and increased knee flexion at initial contact. In another study showed that the step length and pelvic obliquity in scoliotic patients depended on the Cobb angle, and thus the severity of the deformity influenced the gait pathology.[10] Seong et al were reported by altering sensory feedback, plantar pressure distribution is changed during gait. Plantar cutaneous afferents play an important role in plantar distribution.[11]

As above many AIS patients reported that relationship of scoliosis and gait parameter. However, no study, to our knowledge, has assessed the foot weight bearing parameters in AIS. The purpose of this study will demonstrate that relationship between scoliosis and gait factor and foot weight bearing in ambulation.

II. Methods

1. Subjects

Subjects were 40 elementary students who listened to detailed explanation about this study participated after signing a voluntary consent form.

A normal control group consisted of a total of 20 children without any known musculoskeletal disorders and an AIS group of 20 children with mild AIS (defined by a Cobb angle between 10 and 25°) were recruited.

The mean ages, heights and body weights of the scoliosis groups were 11.3 years, 146 cm and 35.2 kg in the normal group 11.9year, 145 cm and 34.2 kg in the mild AIS group (Table 1).

2. Experimental methods

1) Measurement

(1) Scoliosis evaluation

We measured primary scoliosis evaluation using scoliometer screening, subject was assigned normal and AIS group through the scoliometer screening test. The examiner then moves the scoliometer along the vertebral column, starting at the proximal thoracic spine and moving to the distal end of the lumbar spine. Observe the scoliometer for changes in curve measurements, we measured the highest degree of angle during adams forward bending test.

Then divided into groups, a posterior-anterior full-spine standing radiograph was performed to evaluate the Cobb angle curve for children.[12] Cobb angle examined the digitized computer system, Image-Pro Plus 4.1 (Media Cybernetics, USA) was used in all cases. The installed software measures Cobb angle by drawing a line along the predetermined vertebral end plate on the screen.

(2) Gait analysis and foot weight bearing analysis in ambulation

The Smartstep™ pneumatic insole measures gait parameters during ambulation. The data is received and analyzed by the miniature portable microprocessor, which is worn around the ankle. This is then transmitted to a computer running the Smartstep™ software, which also maintains patient medical records and functions as an assessment of gait analysis including weight-bearing distribution (Figure 1), stance/swing phase and gait velosity.

3. Statistical analysis

All measurement parameters were analyzed statistically by independent T test (IBM SPSS statistics 20.0, IBM Inc, USA),

Table 1. General characteristics of the subjects

	Age (years)	Height (cm)	Weight (kg)
Normal group (n=20)	11.9 ± 0.2	145.2 ± 5.1	34.2 ± 5.7
AIS group (n=20)	11.3 ± 0.6	146.2 ± 5.5	35.2 ± 4.7

with within-subject factors of group (AIS or normal). The level for statistical significance was set at P = 0.05.

Figure1. Typical SmartStep™ normal gait analysis reading in walking

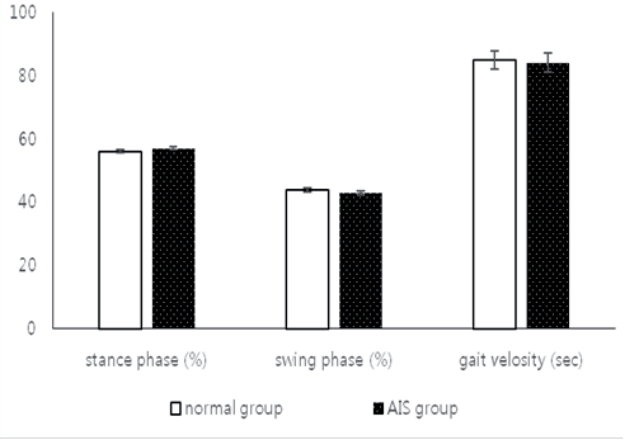

Figure2. Comparison of gait analysis
All values are showed as mean and standard deviation

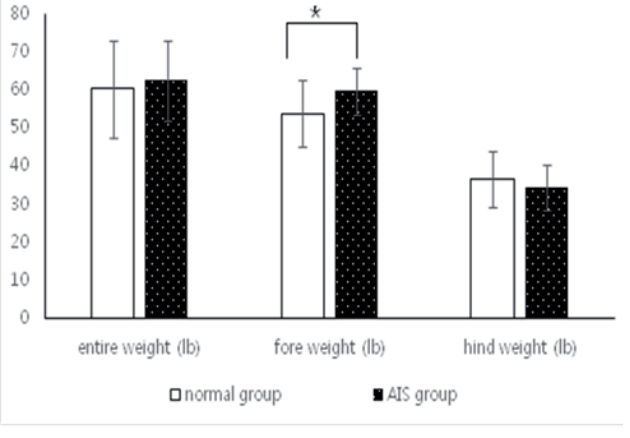

Figure3. Comparison of foot weight bearing analysis in ambulation
All values are showed as mean and standard deviation

III. Results

1. Comparison of gait analysis

A significant difference of group was not found on the rate of stance phase and rate of swing phase and gait velocity(Figure 2).

2. Comparison of foot weight bearing analysis in ambulation

A significant difference of group was also found on the fore foot weight bearing (P = 0.019) was significantly higher in the AIS group. Other measurement element not found significant difference (Figure 3).

IV. Discussion

This study was to assess the influence of spinal deformity on gait in AIS.

The scoliometer screening test and Cobb angle is probably the most widely used parameter for scoliotic curvature. Numerous authors have performed comprehensive reliability analyses on other radiographic measures for scoliosis.[3,13,14] The reliability of radiographic measurement is crucial to treatment of idiopathic scoliosis. The measurements assessed in this study are routinely used in clinical practice. Digital radiograph analysis will become more common as the technology becomes increasingly popular and affordable. However, the reliability of the technology for measuring Cobb angles needs to be evaluated.[15] Therefor in this study were performed using Image-Pro Plus 4.5 to evaluated cobb angle for accurate measurements.

Result of in our study, scoliometer screening test (P = 0.000) was significantly higher in the AIS group. X-ray cobb angle (P = 0.000) according to scoliometer screening test showed similar result. Scoliosis is not only a spinal deformity, but also leads to the development of a pathological gait pattern. Nearly all studies examining walking in scoliotic patients report some degree of gait abnormality.[16]

Nearly all studies examining walking in scoliotic patients report some gait abnormality, however the results are somewhat contradictory. Mahaudens et al found that step length is decreased in scoliotic patients.[8,17] Reductions were also observed in the ranges of motion of the pelvis, hip and shoulder in frontal plane, and knee in sagittal plane these findings that,[8] despite the poor postural stability of this group of patients, their gait patterns do not differ from normal.[18]

Results of the present study showed Influence of the

structural deformity of the spine on the gait pathology in scoliotic patients. However in this study was not found on the rate of stance phase and rate of swing phase and gait velocity. The reason is that it might seem that the sample of our evaluated group is rather small. This was associated with a very strict application of the inclusion criteria, which excluded children with scoliosis other than idiopathic from our study group. Also children progress of physical maturation did not completely. Children have greater flexibility that Seems to be less affected in gait parameter.

The static stability in six postures and gait patterns among normal subjects and IS patients were compared. IS patients in postural stability lead to further understanding of the etiology of idiopathic scoliosis in the postural equilibrium influencing aspects.[18] Idiopathic scoliosis changes orientation of the pelvis during walking at least in one plane, and induces changes in gait stereotype.[19]

This study was performed foot weight bearing analysis in ambulation. Fore foot weight bearing (P = 0.019) was significantly higher in the AIS group. It has been shown that the structural deformity of the spine influences the structure of the foot. The relationship between the structural deformity and weight bearing was therefore also investigated. Therefore, it seems that the results of weight bearing analysis in ambulation may be used in modifying rehabilitation programs for individual needs of patients with idiopathic scoliosis.

References

1. Stokes IA. Three-dimensional terminology of spinal deformity. A report presented to the scoliosis research society by the scoliosis research society working group on 3-d terminology of spinal deformity. Spine (Phila Pa 1976). 1994;19(2):236–48.
2. Gupta P, Lenke LG, Bridwell KH. Incidence of neural axis abnormalities in infantile and juvenile patients with spinal deformity. Is a magnetic resonance image screening necessary? Spine (Phila Pa 1976). 1998;23(2):206–10.
3. Bunnell WP. The natural history of idiopathic scoliosis before skeletal maturity. Spine (Phila Pa 1976). 1986;11(8):773–6.
4. Roach JW. Adolescent idiopathic scoliosis. Orthop Clin North Am. 1999;30(3):353–65, vii–viii.
5. Kane WJ. Scoliosis prevalence: A call for a statement of terms. Clin Orthop Relat Res. 1977(126):43–6.
6. Nissinen M, Heliovaara M, Ylikoski M et al. Trunk asymmetry and screening for scoliosis: A longitudinal cohort study of pubertal schoolchildren. Acta Paediatr. 1993;82(1):77–82.
7. Gummerson NW, Millner PA. (ii) scoliosis in children and teenagers. Orthopaedics and Trauma. 2011;25(6):403.
8. Mahaudens P, Banse X, Mousny M et al. Gait in adolescent idiopathic scoliosis: Kinematics and electromyographic analysis. Eur Spine J. 2009;18(4):512–21.
9. Mahaudens P, Mousny M. Gait in adolescent idiopathic scoliosis. Kinematics, electromyographic and energy cost analysis. Stud Health Technol Inform. 2010;158:101–6.
10. Syczewska M, Graff K, Kalinowska M et al. Does the gait pathology in scoliotic patients depend on the severity of spine deformity? Preliminary results. Acta Bioeng Biomech. 2010;12(1):25–8.
11. Seong D-Y, Kim J-H, Park J-W. The effect of changes in foot cutaneous sensation on plantar pressure distribution during gait. J Korean Soc Phys Ther. 2012;24(5):306–12.
12. Srinivasalu S, Modi HN, Smehta S et al. Cobb angle measurement of scoliosis using computer measurement of digitally acquired radiographs–intraobserver and interobserver variability. Asian Spin J. 2008;2(2);90–3.
13. Kuklo TR, Potter BK, O'Brien MF et al. Reliability analysis for digital adolescent idiopathic scoliosis measurements. J Spinal Disord Tech. 2005;18(2):152–9.
14. Kuklo TR, Potter BK, Polly DW, Jr. et al. Reliability analysis for manual adolescent idiopathic scoliosis measurements. Spine (Phila Pa 1976). 2005;30(4):444–54.
15. Carman DL, Browne RH, Birch JG. Measurement of scoliosis and kyphosis radiographs. Intraobserver and interobserver variation. J Bone Joint Surg Am. 1990;72(3):328–33.
16. Syczewska M, Graff K, Kalinowska M et al. Influence of the structural deformity of the spine on the gait pathology in scoliotic patients. Gait Posture. 2012;35(2):209–13.
17. Mahaudens P, Thonnard JL, Detrembleur C. Influence of structural pelvic disorders during standing and walking in adolescents with idiopathic scoliosis. Spine J. 2005;5(4):427–33.
18. Chen PQ, Wang JL, Tsuang YH et al. The postural stability control and gait pattern of idiopathic scoliosis adolescents. Clin Biomech (Bristol, Avon). 1998;13(1):52–8.
19. Syczewska M, lukaszewska A, Gorak B et al. changes in gait pattern in patients with scoliosis. Medical Rehabilitation. 2006;10(4):12–21.