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Original Article

Change of Range of Motion of the Temporomandibular Joint after Correction of Mild Scoliosis

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Abstract. [Purpose] This study aimed to verify the change in range of motion of the temporomandibular joint on correction of scoliosis. [Subjects and Methods] This study examined 31 male and female participants in their 20s and 30s with a spinal curve degree of 10° or greater. The subjects performed therapeutic exercise based on the pilates exercise system, which is known to be effective in mitigating the spinal curve for patients with scoliosis. All participants completed an 8-week therapeutic exercise regimen to alleviate the scoliosis in which exercise was performed, the exercise was done three times a week for 8 weeks and each session lasted 60 minutes. Among them, 19 participants were selected as an experiment group, whose symptoms were mitigated significantly, and 12 participants who did not undergo the exercise were identified as a control group. All subject was assessed for spinal curve degree, apparent leg length discrepancy, and deviation and range of motion of the temporomandibular joint before and after the study. [Results] In the experimental group, the apparent leg length discrepancy and the deviation of the temporomandibular joint were significantly decreased after the exercise, and the ROM in the temporomandibular joint was significantly increased. In intergroup comparisons, all variables showed a significant difference. [Conclusion] The findings suggest that as the spinal curve degree decreases significantly, the range of motion and deviation in the temporomandibular joint showed a significant change, indicating that mild scoliosis may be a negative factor affecting the deviation and range of motion of the temporomandibular joint.
Key words: Scoliosis, Temporomandibular joint, TMJ ROM

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INTRODUCTION

The spine is critical in maintaining a correct posture, meaning an efficient, natural, good-looking posture that does not put pressure on internal organs, and helps the human body to move in a harmonious way with minimal fatigue. In comparison, a poor posture indicates deformity of the spinal cord, thoracic parts, or arms and legs[1)]. A poor posture is related to asymmetrical use of the body for functional activities, and if prolonged, one's posture is altered due to musculoskeletal imbalance[2)]. It also causes abnormality in vital dynamics and may cause related problems. Among orthopedic disorders, spinal postural change is the most frequently observed[3)]. Specifically, the occurrence of scoliosis is a growing cause of spinal deformity and posture alteration, and it is defined as spinal deformity with a spinal curve 10 degree[4, 5)]. Scoliosis is classified by the degree of curvature as mild (< 20°), moderate (20–45°) and sever (> 45°)[6)]. Mild scoliosis is very common, with the prevalence rate of idiopathic scoliosis of more being 1.5–1.7% and that for 20 degree or more being 0.2% 10[7)]. Regarding treatment of scoliosis, mild scoliosis is treated with physical exercise therapy, moderate scoliosis is treated with a brace and/or cast and physical exercise therapy, and severe scoliosis is treat with surgery[8, 9)].

In adulthood, the majority of patients with scoliosis suffer from back pain, and if the curve progresses to be very large, even pulmonary dysfunction and psychological distress can occur[10)]. The aim of mild scoliosis treatment is to prevent the aggravation of the deformity and pain and pulmonary dysfunction over the course of a lifetime[11)].

Scoliosis can be largely divided into a structural and nonstructural type. The former indicates a curved spine with a rotated vertebra, while the latter shows a symptom of a flat back in trunk flexion and no rotation of the vertebra. Nonstructural scoliosis may accompany pain and muscle spasm may be caused by leg length discrepancy[12)]. Therefore, it might cause abnormal vital dynamics in the musculoskeletal system around the spine and muscle imbalance in the area, and possibly aggravate the scoliosis. Accordingly, it might affect temporomandibular joint mobility, in addition to lumbar and thoracic parts, which is influenced by cervical movement. With this as the background, this study examined the change in the range of motion (ROM) of the temporomandibular joint (TMJ) resulting from a decreased degree of mild scoliosis curvanture.

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Table 1. Correlective exercise for scoliosis

Step	Exercise program
1	Stretch the spine The subjects pushed their hands against the floor while stretching their arms and lowering their spine. 10 repetitions,10 sec each.
2	Lateral spine stretch on concave side The subjects knelt laterally beside a Swiss ball. While exhaling, they performed lateral spine flexion on the Swiss ball according to the direction of convexity of the scoliosis. They then took a breath, exhaled, and returned to the intial position. 10 repetitions.
3	Muscle strengthening In a side-lying position on the concave side, the subjects performed a trunk lift for antigravity strengthening if the lateral trunk muscle. 10 repetitions, 10 sec each.
4	Trunk strengthening on a stable surface The subjects lifted their trunk and performed curl-ups on a mat. 10 repetitions, 10 sec each.
5	Trunk strengthening on an unstable surface The subjects lifted their trunk and performed curl-ups on a Swiss ball. 10 repetitions, 10 sec each.

SUBJECTS AND METHOD

Subjects

This study examined 31 male and female participants in their 20s and 30s with a spinal curve of 10° or more. The inclusion criteria for subjects were no experience of spinal surgery or other special therapy including exercises. The degree of spinal curvature, apparent leg lengths, and deviation and ROM of the temporomandibular joint mobility were measured for all participants. The subjects were randomly divided into an experimental group and control group. The experimental group consisted of 19 participants performed an 8-week exercise regimen to alleviate scoliosis. The 12 participants in the control group who did not perform the exercise. After the exercise regimen, the apparent leg lengths and, deviation and ROM of the temporomandibular joint mobility were measured again to analyze the impact of the spinal curve degree on the temporomandibular joint.

The subjects were selected from among those who understood the purpose of this study and were capable of understanding and complying with the tester's instructions. All subjects understood the purpose of this study, agreed to participate in this research, and signed an informed consent form approved by the Institutional Review Board.

Methods

Weight and height of all subjects were measured. Then, each subject was assessed for degree of spinal curvanture, apparent leg length discrepancy and deviation and ROM of the TMJ. To measure the degree of spinal curvanture, a landmark was checked on the spinous processes of the subjects' C7, T7, T12, and L5 vertebrae, and photos were taken with a digital camera. To measure the deviation of the temporomandibular joint, the subjects opened their mouths to the maximum and were then photographed with a digital camera. Analysis of the images was performed using the Global Posture System (GPS, Chinesport, Udine, Italy), a body alignment analysis program. For the degree of spinal curvanture, the angle of a line that connecting the landmarks on the aforementioned spinous processes was measured. The deviation of the angle connecting the median clefts of the upper and lower teeth was measured in degrees. As for the leg length discrepancy, the distance between the navel and the medial malleolus was measured for both legs[13]. The range of joint motion with maximal opening of the TMJ was measured in millimeters as the distance between the median clefts of the upper and lower teeth using a goniometer.

The subjects in the experimental group performed therapeutic exercise that is known to be effective in mitigating the spinal curve in patients with scoliosis. Specifically, the exercise was performed three times a week for a total of 8 weeks, and each session lasted 60 minutes. Each set consisted of three steps: 10 minutes of warming up, 40 minutes of therapeutic exercise, and 10 minutes of cooling down. The warm-up and cool-down exercise included walking and stretching of various body parts. For therapeutic exercise, the subjects used a Swiss ball or other adequate equipment for stretching exercise. Stretching exercise was performed to increase lateral trunk flexibility on the concave side. Strengthing was performed to strengthen the lateral trunk muscle on the convex side. In the beginning, each exercise was performed with 10 repetitions, and the number of repetitions was increased according to the subject's physical strength (Table 1)[1, 14].

Statistical analyses were performed using SPSS version 14 for Windows (SPSS Institute Korea, Seoul, Republic of Korea), and the results are presented as mean±SD. In order to analyze the changes in the degree of spinal curvature, apparent leg length discrepancy, and ROM and deviation of in the temporomandibular joint between the before and after the exercise period, the paired t-test was used for the changes within each group, and an independent t-test was used for comparison between the two groups. Statistical significance was accepted for values of $p<0.05$.

RESULTS

The characteristics of the 31 participants in this study are shown in Table 2. In the experimental group, the apparent leg length discrepancy and the deviation in the tem-

Table 2. Characteristics of the subjects

	Control group (n=12)	Exercise group (n=19)	All subjects (n=31)
Female	8	13	21
Male	3	6	9
Thoracic scoliosis	5	16	21
Lumbar scoliosis	7	3	10
Age (years)	22.1±6.1	23.6±2.5	22.7±5.1
Weight (kg)	57.1±10.3	61.6±15.8	59.6±13.2
Height (cm)	162.2±9.7	165.1±8.2	163.8±8.8

poromandibular joint decreased significantly between before and after the exercise ($p<0.05$), and the ROM in the TMJ significantly increased signigicantly ($p<0.01$). In the intergroup comparison, all variables showed a significant difference ($p<0.01$). The findings suggest that as the degree fo spinal curvature decreases significantly, the ROM and deviation of the temporomandibular joint show a significant difference, indicating that nonstructural scoliosis has a significant impact on the deviation and t ROM of the TMJ (Table 3).

Table 3. Comparison of degree of spinal curvature, ALLD, and ROM and deviation of the TMJ within group between groups, and between before and after the exercise period

	Group	Before	After
Degree of spinal curvature	1	11.8±1.6	11.8±1.5
	2	11.7±0.9	11.0±0.8†‡
ALLD (mm)	1	9.5±0.4	9.4±0.5
	2	10.6±0.8	10.0±0.6*‡
ROM (mm)	1	39.2±6	39.1±2
	2	42.5±7	48.1±8†‡
Deviation (°)	1	2.0±0.6	1.9±0.9
	2	2.0±0.5	1.5±0.6*‡

1, Conrol group; 2, exprimental group; ALLD, apparent control leg length discrepancy
*$p<0.05$ compared with before the exercise period; †$p<0.01$ compared with before the exercise peroid; ‡$p<0.01$ compared with the control group

DISCUSSION

This purpose of this study was to examine the effect of scoliosis on TMJ mobility. Scoliosis has a higher prevalence in female[15)]. This study had more female subjects than male subjects. Ideally, in the human body, the spine should be perpendicular to the frontal plane to maintain a normal posture. The alignment of the pelvic and lumbar bones influences the thoracic bone, which in turn, affects the location of the neck and the head. Thus, if the thoracic spine curves to one side, it is hard to maintan a balance in the pelvic bone[1)]. The balance of the pelvic bone can be checked with the apparent leg length. The result of the present study show that the scoliosis patients' leg length discrepancy decreased significantly when their spinal curve was mitigated, suggesting that the pelvic balance could affect the nonstructural scoliosis.

The maximum mouth opening distance is a generally accepted measurement of temporomandibular joint mobility and function[16)], and it was used for this study. When the mouth is open, the normal range of motion should be 40–60 mm[16, 17)], The same range was 39–42 mm before the exercise period but increased to 48 mm after the exercise preiod, indicating that scoliosis reduced the range of mobility. The temporomandibular joint is surrounded by ligaments, muscles, nerves, and blood vessels[18)]. The masticatory muscles enable mouth opening and closing, lateral movement, and forward and backward movement of the mouth[19)], and excessive tension or imbalance of muscles can limit the joint movements, possibly resulting in limited ROM. Thus, it can be surmised that the imbalance in the spinal muscles caused the imbalance in the temporomandibular muscles and limited TMJ mobility.

Himiko et al.[20)] argued that 27% of patients with jaw deformity (lateral displacement) experienced the scoliosis with a Cobb angle of 10° and more. The lateral displacement of the mandible is an indicator of the functioning of the masticatory muscles[21)]. Thus, imbalance of the masticatory muscles of the TMJ may occure if activities are continues when the mandible is displaced, resulting in problem with movement. The deviation of the TMJ has been suggested to be the result of imbalance in the jaw-opening muscles or spasm of the jaw-opening muscles on the side opposite to the deviations[22)]. The imbalance in the masticatory muscle damages the functioning of mastification, and possibly expands the range of malocclusion-related disorders[21)]. Thus, it can be said that scoliosis affects the deviation of the temporomandibular joint. The findings of the present study are consistent with previous studies that showed a correlation between scoliosis and TMJ dysfunction, and that interaction could be found between orthopedic deformities of the spine and the orthodontic deformities.

The present study shows that scoliosis could be a factor that restricts the ROM of the TMJ and increases its deviation such that it affects the mobility of the TMJ by causing an imbalance in the masticatory muscle of the mandibular, in addition to causing imbalance in the muscles around the spine. Therefore, mild scoliosis may be a negative factor affecting deviation and ROM of the TMJ. The limitations of the this study were that the subjects were not limited with respect to activities daily of living and that the subjects selected mild scoliosis and nonstructrural scoliosis. Consequently, follow-up studies are called for to examine cases of structural scoliosis for a broader application of the research results.

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