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## A Single Case Study on KINEMATIC Correction of the Idiopathic Scoliosis Using Sling and Schroth

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### Abstract

*Purpose; This study was performed to evaluate the therapeutic effect of correction of idiopathic scoliosis using Sling and Schroth.*

*Method: A 24-year-old woman who was diagnosed with idiopathic scoliosis was selected as a study participant, and one year Sling and Schroth program were applied to her. Using the thermography photo device and the thermography camera as a measurement tool, this study investigated the tendency of spinal alignment in the baseline(A), duration of treatment(B), and after treatment(A'). This study was analyzed by graphical visual analysis and mean value, and the following conclusions were obtained. First, in analyzing somatotype photos over the third period, this study observed changes in the left and right deviation of the trunk on the front and back sides, rear shoulder angle deviation, and lateral cervical curvature angle.*

*Results: It was confirmed that the left and right deviation from the front and the rear was reduced, the deviation of the left and right shoulder angles at the rear was also reduced, and that the lateral cervical curvature angle was also reduced. Second, in the analysis of the thermography over three times, temperature changes were observed at the front and back of the upper body, the front of the lower body and the back of the lower body.*

*Conclusion: This study suggest that long-term exercise correction using Sling and Schroth affects the somatotype photos and thermography of patients with scoliosis. Therefore, it is thought that Sling and Schroth exercise treatment seem to have a positive effect on the treatment of patients with idiopathic scoliosis.*

**[Keywords]** Kinematic, Correction, Sling, Schroth, Idiopathic Scoliosis

## 1. Introductions

Modern society is getting tame to the lifestyle which minimizes the movement and destabilizes the spine as it is gradually becoming scientific and pursuing convenience in modern life accordingly. As a result, the spine of modern people is exposed to various spinal diseases. According to data from Korea's Health Insurance Review and Assessment Service[1], the number of cases of spinal disease treatment increased by about 41.3 million(88.4%) from about 46.6 million in 2007 to 87.9 million in 2014, and the cost of medical care increased by about 1.889 trillion won(95.2%) to about 3.876 trillion won in 2014 from about 1.986 trillion won in 2007[2]. In congenital idiopathic scoliosis, the incidence is high in the teenage of all ages and the female is more than twice as high as that of the male, and it can be seen that the prevalence rate is high in the adolescence period which is the secondary sexual character period.

If the diagnosis is delayed during the period of rapid progression of scoliosis, the appropriate treatment period is to be missed. Considering the research report[3] that it may be difficult to

correct the curved waist and may require surgery correction, it can be assumed that the timing and method of scoliosis correction in adolescence is very important.

The scoliosis is an anatomically curved or lateral deviation of the vertebra from the axis of the midline, usually accompanied by a rotational deformation of the vertebrae, and a status where a normal curvature of the vertebrae is lost(Seoul National University Hospital, 1994). Treatment for the improvement of scoliosis is usually surgical and conservative treatment, and even after surgery, the curvature of the vertebrae cannot[4]. Therefore, it is necessary to apply conservative treatment method rapidly to prevent further progression of curvature, to correct the progress of scoliosis, and further, continuous treatment with exercise should be performed to reduce the curvature angle.

Spinal scoliosis is classified into two major categories: first, structural scoliosis and second, non-structural scoliosis. Structural scoliosis is classified as idiopathic scoliosis(unclear), congenital(scoliosis resulting from spinal deformity at birth), nerve roots(scoliosis caused by neurological or muscular disorders), which account for 85% to 90% of total scoliosis. Unstructured scoliosis is not a true scoliosis due to trauma, such as traffic accidents, or, more precisely, a scoliosis caused by a disease that does not occur in the vertebra itself due to the difference in leg length[5].

Structural scoliosis has not yet been identified, so no definitive treatment has been proposed, demanding that there should be studies to be continued. Unstructured scoliosis can be caused by a pelvic deviation caused by a severe deviation of leg length, a severe accident in a traffic accident, a twisting of the body, or a complete spinal deformation due to old habits. Although idiopathic scoliosis has been hypothesized for several reasons, its causes have not been clearly elucidated[6][7]. Thus, this study aims to investigate the effects of Sling and Schroth exercises on idiopathic scoliosis through a single case study using data from a 1-year clinical trial to improve idiopathic scoliosis.

Since the introduction of the Sling movement since 1997, physiotherapists have been advancing, recently, the sports center and the professional exercise center have been opened, and the treatment that has been conducted in the center of the hospital has been continuing with various angles. Sling is a device that helps the patient to perform active exercise by using a wobble line. This is a treatment technique that has been used in conjunction with aquatic exercise therapy as a way to treat weakness in polio patients in Europe during World War II[8].

Schroth exercise therapy was developed by Katharina Schroth of Germany. It is an exercise therapy approach which is applied to the spinal defect by applying the basic rule of 3-D scoliosis treatment. This is a exercise method of restoring structure and function by using an inverse three-dimensional approach(de-rotation, counter-flexion, and re-kyphosis) in torsion and spine and thorax and pelvis in three-dimensional surfaces(sagittal, frontal, and horizontal) typically seen in patients with Scoliosis.

To look at the result of a recent study on Sling exercise and a study[9][10][11] on Schroth's treatment, in recent years, non-surgical exercise therapy for musculoskeletal diseases has been actively under way. Also, a study on non-surgical treatment of scoliosis correction with Sling and Schroth[8] is under way, but it is still insufficient. This study was carried out to investigate the effect of exercise therapy using Sling and Schroth on idiopathic scoliosis correction and somatotype change of women employees in their twenties. These findings are expected to provide new clinical data for scoliosis treatment and exercise therapy.

## 2. Methods

### 2.1. Participant

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The subject of this study is the one who has fully understood the purpose and method of this study, and agreed to participate in the study from among those who has been diagnosed as having idiopathic scoliosis on X-ray at the sports center located in the S city of Korea. A 24-year-old woman with idiopathic scoliosis who had a long sitting and working career was selected for the study. Thus, she was in an environment where the spinal part that was changed was inevitably more twisted. Therefore, the participant was selected for the purpose of the study according to the characteristics of the single case study, the subject without idiopathic scoliosis was selected as subjects.

## 2.2. Instruments

To accomplish the purpose of this study, thermography photo device and thermography camera were used as a measurement tool. The somatotype camera is the BODY CHECKER of Ghiwell Co., Ltd. with the model name, GHB-1100, and it is used to measure the front, back, and side somatotype photos of the participant. For the thermography camera, T-1000 XD of Mesh co., Ltd. was used as a measuring tool for the thermography front, back, upper body, and lower body of the participant in this study.

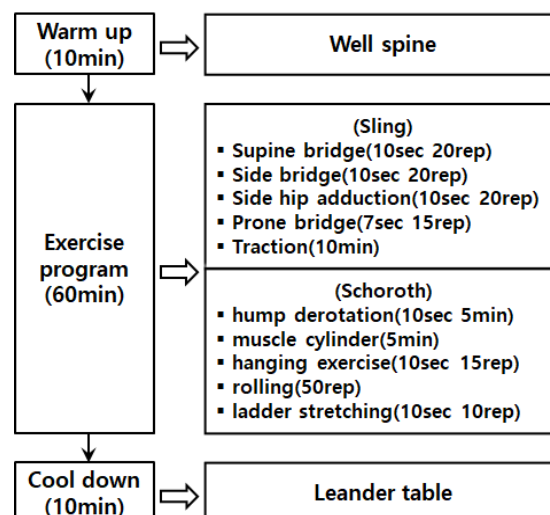
## 2.3. Procedure and program

To proceed with this study, we conducted a preliminary study and a literature review on research questions, and after selecting the appropriate subject for idiopathic scoliosis, the consent form was written and the contents of the experiment and the treatment process were explained. This study compared one year baseline, treatment, and post-treatment somatotype photos and thermography for analysis and reported the results. The results of this study are summarized as follows. All the motions used in Sling and Schroth programs were reconstructed by referring to the exercise methods used in related literature and previous studies[12][13][14], and were conducted twice a week for the first 3 months, then once a week for 9 months. <Figure 1> shows the posture, name and exercise time of the Sling and Schroth exercise program performed by the participant.

## 2.4. Data analysis

To investigate the tendency of spinal alignment in the baseline(A), treatment process period(B), and post-treatment(A'), the analysis was conducted using graphical visual analysis and mean values. Data collected for each measurement session were visually analyzed by plotting points on the graph to improve the reliability of the study results and to improve the accuracy of the results analysis, measured somatotype photos data and thermography data were presented, and the change values according to the measurement were tabulated.

**Figure 1.** Sling and Schroth exercise program.



### 3. Results

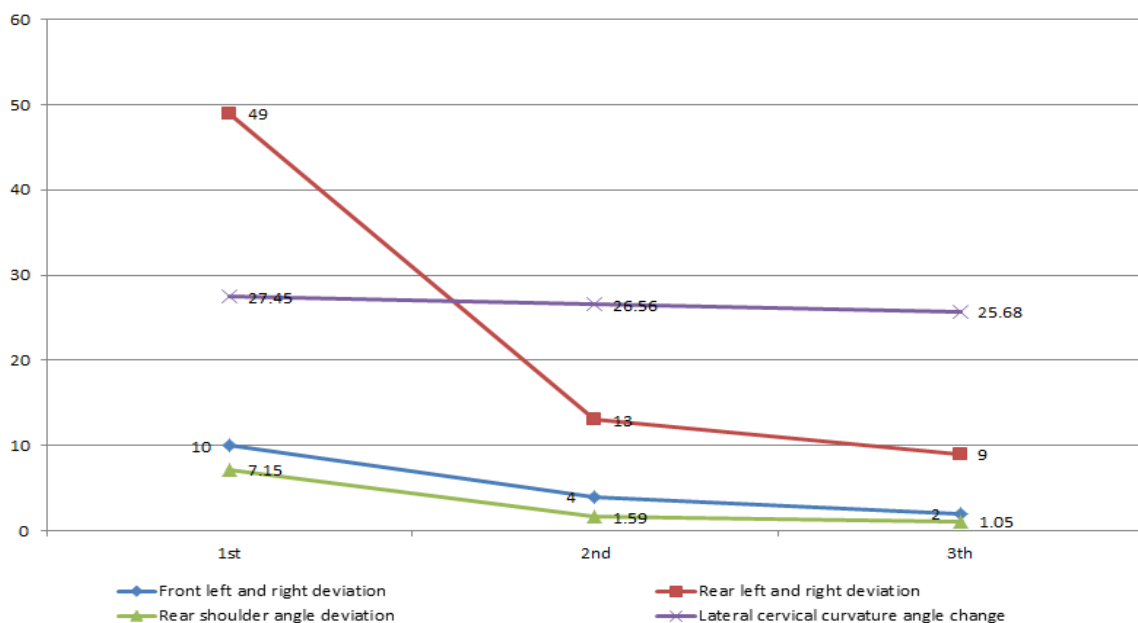
#### 3.1. Comparative analysis of somatotype photos

In this study three different somatotype photos were taken after correction using Sling and Schroth for three times, and the left and right deviation of the body was confirmed on the front and back sides, and the change of the cervical curvature angle was confirmed on the side. As a result, it was confirmed that the lateral deviation from the front and rear sides was reduced, and that the deviation of the shoulder angle from the rear was also reduced. In addition, the cervical curvature angle was found to be reduced on the side. Analysis of participants' somatotype photos is shown in <Table 2> and <Figure 2> below. In comparison of the somatotype photos of the participant, in the front was 97mm and 107mm with 10mm difference in the 1st, 88mm and 92mm with 4mm difference in the 2nd, and 90mm and 92mm with 2mm difference in the 3rd.

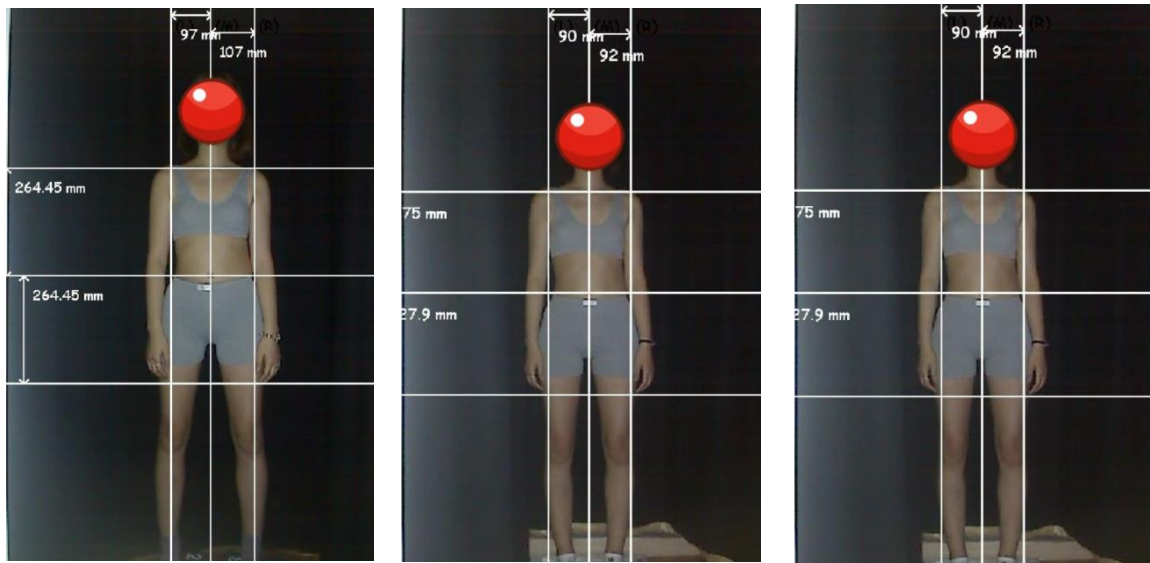
**Table 1.** Participant somatotype photos comparison values of left/right, shoulder symmetry, lateral cervical curvature angle(unit: mm, degree).

Division	1st		2nd		3th	
Front left and right deviation	97mm	107mm	88mm	92mm	90mm	92mm
	Deviation 10mm		Deviation 4mm		Deviation 2mm	
Rear left and right deviation	101mm	150mm	112mm	125mm	103mm	112mm
	Deviation 49mm		Deviation 13mm		Deviation 9mm	
Rear shoulder angle deviation	24.07°	16.92°	32.10°	30.51°	19.13°	18.08°
	Deviation 7.15°		Deviation 1.59°		Deviation 1.05°	
Lateral cervical curvature angle change	27.45°		26.56°		25.68°	
	Change 0.89°				Change 0.88°	

**Figure 2.** Comparison of change in somatotype photos.



**Figure 3.** Changes in cervical curvature angle of somatotype photos.



### 3.2. Comparative analysis of thermography

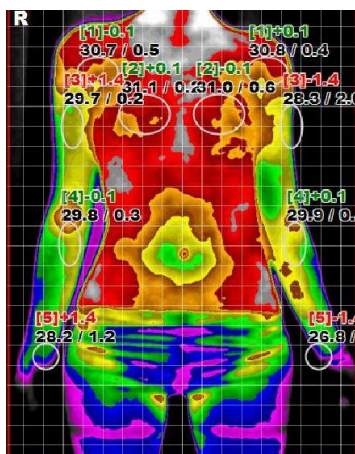
In this study, we took thermography three times along with somatotype photos. The results of the study can be measured by temperature change, and were divided into first, second and third for the shooting and analysis. In the 1st, there were 27.2 degrees on the upper body, 24.5 degrees and 25.9 degrees on the upper body, 22.7 degrees and 23 degrees on the lower body front, 21.4 degrees and 22.1 degrees on the lower body, 23.8 degrees and 23.7 degrees on the lower body, 23.2 degrees and 22.2 degrees on the lower body. In the second, on the upper body was 28.4 degrees, on the upper body was 26.8 degrees and 28.2 degrees, on the lower body front was 24.3 degrees and 24.4 degrees, 27 degrees and 24.9 degrees, on the lower body was 25.2 degrees and 25.7 degrees. The change in temperature was observed at 31.1 degrees and 31 degrees on the upper body, 28.8 degrees and 29.3 degrees on the upper body, 28.0 degrees and 27.9 degrees on the lower body, and 26.1 degrees and 26.4 degrees on the lower body. <Table 3> shows the comparative values of temperature change of participant's thermography. The following <Figure 4> is the measurement of body temperature change during thermography shooting.

**Table 2.** Comparison of thermography temperature change of the participant(unit: degree).

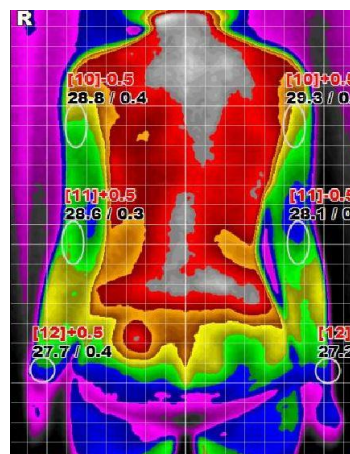
Division	1st		2nd		3th	
Front upper body	27.1	27.0	28.3	28.3	30.7	30.8
	27.2	27.2	28.4	28.1	31.1	31.0
	25.8	25.9	26.1	25.2	29.7	28.3
	26.9	26.7	27.6	28.2	29.8	29.9
	25.4	20.8	26.8	25.2	28.2	26.8
Rear upper body	24.5	25.9	26.8	28.2	28.8	29.3
	24.2	24.7	26.3	23.5	28.6	28.1
	24.9	24.9	25.0	27.3	27.7	27.2
Front lower body	22.7	23.0	24.3	24.4	28.0	27.9

	22.0	21.8	24.8	24.4	26.1	26.4
	21.4	22.1	27.0	24.9	27.4	25.7
	20.9	20.7	25.3	25.1	23.4	24.9
Rear lower body	23.8	23.7	25.2	25.7	29.4	29.7
	23.2	22.2	25.0	25.1	27.7	27.8

**Figure 4.** Thermography temperature change of the participant.



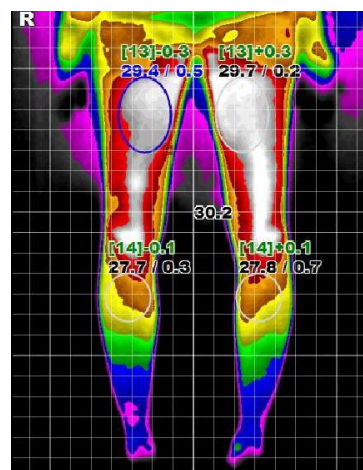
Front upper body



Rear upper body



Front lower body



Rear lower body

#### 4. Conclusion

In this study, Infrared Thermal Imaging (ITI), which detects the heat emitted from the surface of the human body, is non-invasive and provides objective image data to diagnose diseases. Thermography, which has advantages of high sensitivity, non-invasive points and simple instrument manipulation, in the case of a diagnosis of spinal nerve root compression symptoms or complaints of diaphragmatic pain in the lower limb not revealed by spinal angiography, is used

as an objective diagnostic and evaluation method for muscle ligament injuries of the lumbar region, inflammation and tumors of the spine. It is used not only for diagnosis but also for post-treatment evaluation, and has also been used as an adjunct to quantitative assessment of pain and assessment of muscle condition, herniated disc, peripheral nerve damage, and diagnosis and treatment of autonomic nervous system disorders[15]. The findings of these studies show that body temperature is an important indicator of symmetry of the body, and the skeletal disorder is to be asymmetric if it has scoliosis.

The problem of vertebral deformity is sitting for a long time in an unsuitable position on the desk, relatively lack of exercise results in muscle weakness supporting the spine, or when the musculoskeletal system is rapidly growing, it may become structurally unstable and may be bent in various ways such as a waist while being taller. The most frequent occurrence is scoliosis[16][6]. In the case of idiopathic scoliosis, the cause of which is unknown, although surgical treatment is considered as treatment methods, but in general, non-surgical treatment methods such as exercise therapy, electrical stimulation therapy, orthosis use, traction therapy, frequency therapy, and Schroth exercise approach are considered as treatment methods[17][18][19].

To date, general scoliosis therapy focuses on changes in strength and spinal morphology that affect the degree and rate of deformation, and there is a lack of research focused on the change in reduced thoracic expansion capacity due to scoliosis caused by scoliosis. Deformation of the vertebral skeleton due to scoliosis results in restriction and imbalance of the thoracic expansion, and severe deformation of thoracic vertebrae may result in increased respiration and reduced pulmonary flexibility resulting in short and shallow respiration.

Thus, to investigate the effect of Sling and Schroth exercises on scoliosis patients, this study applied exercise programs for one year, twice a week for the first three months, eight times a month, and the other nine months, once a week, four times a month, and evaluated and compared changes of somatotype photos and thermography. There was a significant difference in flexibility, strength, and balance ability in the related studies using Sling and Schroth exercise therapy for scoliosis patients, and In a study of comparison of Schroth exercise and correction exercise therapy[20], Schroth and correction exercise programs showed a significant effect on reduction of spine angles and pulmonary function parameters. In a study in which a Sling exercise program was applied to patients with scoliosis[9][13], Sling exercise was found to have a significant effect on body fat, lumbar muscle strength, balance ability, flexibility and vertebral angle. In previous studies that applied Schroth's exercise treatment to scoliosis patients, they focused mainly on the scoliotic angle, but in the studies[8][21] who measured flexibility, there was a significant difference in flexibility before and after Schroth exercise.

It is thought that the Sling and Schroth exercise treatment strengthened weakened muscles and decreased the spinal angles due to muscle imbalance. In addition, both exercise methods were able to perform isolated exercise and whole body exercise, so strengthened muscles weakened by local exercise and using both right and left muscles as a whole body exercise seemed to help to reduce vertebral angle. Lateral curvature due to scoliosis interferes with the growth of the thoracic and lungs, leading to weakness of the respiratory muscles and impaired cardio-pulmonary function[14].

This study showed that Sling and Schroth had a significant effect on the correction effect of idiopathic scoliosis. It is difficult to generalize to all subjects because this study is conducted on a single case of one subject, but this study is meaningful in that it is to provide information to help set up and manage the planning and direction of exercise program for patients with idiopathic scoliosis.

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## 6. Contribution

### 6.1. Authors contribution

	Initial name	Contribution
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Corresponding Author*	LJB	-Corresponding <input checked="" type="checkbox"/> -Play a decisive role in modification <input checked="" type="checkbox"/> -Significant contributions to concepts, designs, practices, analysis and interpretation of data <input checked="" type="checkbox"/>
Co-Author	KHW	-Participants in Drafting and Revising Papers <input checked="" type="checkbox"/> -Someone who can explain all aspects of the paper <input checked="" type="checkbox"/>

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