Research Report

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Comparative Effects of Leaflet- and Video-Guided Core Stabilization Exercises on Juvenile Idiopathic Scoliosis

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Background Juvenile idiopathic scoliosis (JIS) carries a higher risk of developing several deformities compared to adolescent idiopathic scoliosis, necessitating proactive and early management.

Purpose To evaluate the effectiveness of leaflet- or video-based instruction for home core stabilization exercises in JIS.

Study design Retrospective observational comparative study

Methods A total of 36 children diagnosed with JIS (Cobb angle 10–20°) who visited a rehabilitation clinic were included. Participants performed home-based core stabilization exercises for 6 months, guided either by a printed leaflet (n = 22) or an instructional video (n = 14). Whole-spine radiographs were obtained before and after the intervention to assess changes in Cobb angle and vertebral rotation. Endurance was evaluated by measuring the duration participants could maintain the bird-dog and Superman positions in the clinic. Statistical analyses included the Wilcoxon signed-rank test and the Mann–Whitney U test for within- and between-group comparisons, respectively.

Results Both groups demonstrated significant within-group improvements in Cobb angle and bird-dog endurance ($p < 0.05$). Additionally, no statistically significant differences were observed between the leaflet- and video-based groups in changes to Cobb angle, rotation, or endurance measures ($p > 0.05$).

Conclusions Leaflet- and video-guided home-based core stabilization exercises were equally effective in improving spinal curvature and trunk endurance in children with JIS. Either instructional method may be suitable for supporting adherence to home exercise programs.

Key words Core stabilization exercise; Juvenile idiopathic scoliosis; Leaflet; Video

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INTRODUCTION

Idiopathic scoliosis (IS) is a structural lateral curvature of the spine with an unknown etiology.[1] It is classified into three categories based on age: infantile (0 to 2 years and 11 months), juvenile (3 to 9 years and 11 months), and adolescent (10 to 17 years and 11 months).[1] Among these three types, adolescent idiopathic scoliosis (AIS) is the most common and has been the focus of most studies, while research on juvenile idiopathic scoliosis (JIS) is less common. However, previous studies have shown that 70% of JIS cases progress and require treatment, with 56% needing spinal surgical management.[2,3] This suggests that JIS carries a higher risk of developing several deformities compared to AIS, necessitating proactive and early management.[1] Core stabilization exercise is one of the physiotherapeutic scoliosis-specific exercises (PSSE) methods used to improve IS. Previous study have shown that core stabilization exercises in IS can reduce trunk rotation and pain, and improve body symmetry and cosmetic appearance.[4] These exercises are relatively simple and can be performed at home using guidance materials such as leaflets or videos. This study aimed to determine whether leaflets or video materials are more effective in helping children with juvenile idiopathic scoliosis (JIS) perform core stabilization exercises at home.

Clinical intervention for IS during growth is generally not recommended when the Cobb angle is less than 20º; periodic observation is the standard approach.[4-5] However, with increased health awareness and advances in physical therapy, active interventions like PSSE are more commonly sought. Recent study has shown significant improvement in Cobb angle and trunk rotation angle when PSSE is applied to JIS.[7] However, the PSSE used in these studies involves the over-correcting training of the Schroth approach, making it difficult to perform at home without guidance from a physical therapist. In Korea, with dual-income households comprising 46.3% of families in 2018 and increasing, it is increasingly difficult for parents to bring their children to rehabilitation clinics for supervised PSSE.[8]

METHODS

Participants

This retrospective study included children with JIS who visited a rehabilitation outpatient clinic between June 2022 and June 2024. Inclusion criteria were as follows: (1) age between 3 and 9 years and 11 months; (2) Cobb angle between 10 and 20º; (3) Prepubertal children. The exclusion criteria were as follows: (1) patients who received any intervention before the treatment, such as braces or PSSE; (2) history of spine surgery or injury; (3) patients with intellectual disability and inability to understand instructions; (4) those with vertebral deformities. This study was approved by the Institutional Review Board from a tertiary university hospital (EUMC 2024-09-033). All patient data were de-identified by removing personal identifiers such as names and addresses. The requirements for informed consent were waived due to the retrospective design of the study and the use of anonymized patient data.

Measurement

1) Cobb angle test

The Cobb angle was assessed by analyzing the thoracic and lumbar curvatures on standing anterior-posterior whole-spine radiographs. Using the Cobb method, the curvature angle is determined by drawing lines parallel to the upper edge of the highest vertebra and the lower edge of the lowest vertebra within the structural curve. Perpendicular lines are then drawn from these reference lines, and the angle created at their intersection is referred to as the 'angle of curvature.'[9] Whole-spine X-rays were obtained before participating in the core stabilization exercise program and again six months after completion.

2) Rotational degree

Given that scoliosis involves a three-dimensional spine deformity, conventional measurements focusing solely on Cobb angles have limitations when evaluating axial plane deformities. While there are several methods for measuring axial rotation in IS, this study employed the Nash-Moe method.[10] The Nash-Moe method estimates vertebral rotation by calculating the percentage of displacement of the convex pedicle relative to the width of the vertebral body. This method is widely used in clinical settings to evaluate vertebral rotation. [11] In this method, the apical vertebral body is divided longitudinally into six equal segments. A grade of '0' is assigned when both pedicles are visible, indicating no vertebral rotation. When the pedicle on the concave side (right side) starts to fade, it is graded as '1.' If the concave pedicle becomes completely obscured, it is graded as '2.' When the contralateral pedicle (on the convex side) aligns with the midline of the vertebra, it receives a grade of '3.' If it crosses the midline, the rotation is graded as '4.'[10] The Cobb angle and vertebral rotation degree were evaluated by a board-certified physiatrist with over 5 years of experience in musculoskeletal imaging and scoliosis assessment.

3) Endurance of specific posture

Before and after the 6-month intervention, the duration for which participants could maintain bird-dog and Superman positions was recorded, as illustrated in Figure 1. For the bird-dog position, both variations were executed (raising the right arm and left leg and the left arm and right leg), and the average time was calculated. Endurance in the Superman position was measured by timing how long participants could keep both arms and legs elevated off the ground. If participants held the position for more than 10 s, the measurement was capped at 10 s.

Intervention: Core stabilization exercise program

The core stabilization exercises in this study included bird-dog and Superman exercises. In the bird-dog exercise, participants were instructed to lift their right arm and left leg, or left arm and right leg, while maintaining a quadruped position, holding it parallel to the ground for 10 s. This was repeated 10 times on each side, resulting in 20 repetitions (Figure 1). For the Superman exercise, participants lifted both arms and legs simultaneously and held the position for

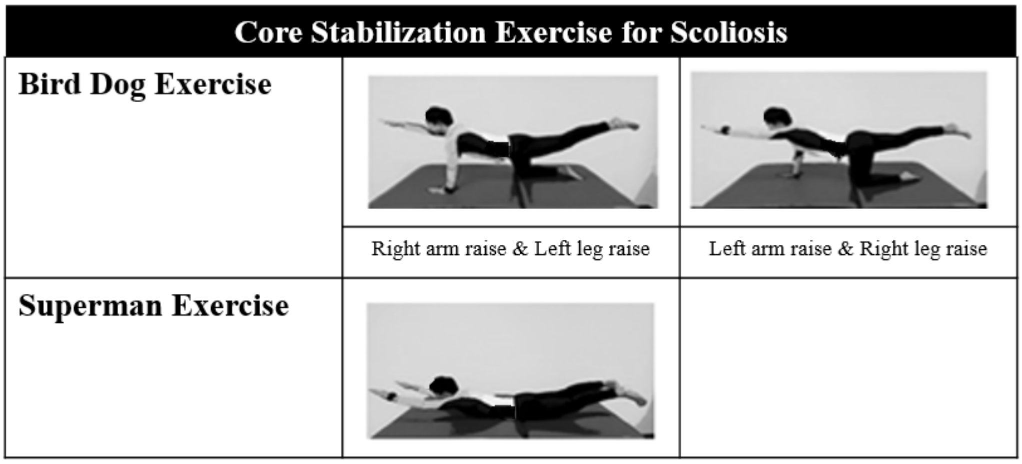

Figure 1. The leaflet provided to the leaflet group in this study.

10 s, repeated 10 times (Figure 1). Each set of core stabilization exercises took approximately 10 min to complete, and participants were advised to perform the exercises three times daily for 6 months.

Patients enrolled between June 2022 and June 2023 performed core stabilization exercises based on a leaflet, as the YouTube video had not yet been produced. From July 2023 onward, patients were assigned to the video-based group using the newly created YouTube instructional material. This non-randomized allocation was based on the timing of the video production.

1) Leaflet-based group

In the leaflet-based group, participants were shown how to perform the exercises in the clinic using a leaflet. The participants were instructed to practice the exercises daily at home, completing three sets per day (Figure 1). They were advised to refer to the leaflet while practicing at home.

2) Video-based group

In the video-based group, exercises were demonstrated in the clinic using a YouTube video (https://www.youtube.com/watch?v=5enflsyuLkI). Participants were instructed to practice the exercises daily at home, completing three sets per day. Each participant received a written link to the video and was encouraged to follow along while performing the exercises at home.

Statistical analysis

All statistical analyses were performed using SPSS version 21.0 software (SPSS Inc., Chicago, IL). The Shapiro-Wilk test was conducted to assess the normality of the data, and the results indicated that the assumptions of normality were violated. Therefore, non-parametric tests were applied. The Mann-Whitney U test was used to compare pre- and post-exercise values and to assess the differences in radiographic parameters and posture endurance between the leaflet and video groups. The Wilcoxon signed-rank test was used to compare radiographic parameters and posture endurance before and after the 6-month intervention within each group. Statistical significance was set at $p<0.05$.

RESULTS

A total of 36 children with JIS participated in this study, with 22 in the leaflet-based group and 14 in the video-based group. The mean age of the children was 8.50±0.70 years (Table 1).

Before and after the 6-month intervention period, the leaflet-based and video-based groups showed no significant differences in terms of Cobb angle, degree of rotation, or endurance in the bird-dog and Superman positions. Similarly, when calculating the differences between pre- and post-intervention results, no significant differences were observed between the leaflet-based and the video-based groups (Table 2).

However, within-group comparison before and after the 6-month exercise period showed significant improvement in both groups in terms of endurance in the bird-dog posture and Cobb angle. In the leaflet-based group, endurance in the bird-dog posture improved significantly from 3.18±4.77 s to 5.91±5.03 s (p=0.034), while in the video-based group, it improved significantly from 5.71±5.14 s to 9.29±2.67 s (p=0.025). Regarding the Cobb angle, the leaflet-based group improved from 12.19±1.74° to 7.10±4.59° (p=0.000),

Table 1. Demographic data of the children with Juvenile idiopathic scoliosis (N = 36)

		Median (Interquartile range, 25–75%)
Age (years)	The youngest : 7 years The oldest: 9 years	9.00 (8.00-9.00)
Gender	Male	5
	Female	31
Group	Leaflets	22
	YouTube videos	14
Height growth (cm) over 6 months		2.40 (1.43-3.95)

Table 2. Pre- and post-intervention comparison between leaflet- and video-based groups

		Bird dog (sec)	Superman (sec)	Cobb's angle (degree)	Rotation degree[1]
Leaflet-based group	Pre	3.18±4.77	9.55±2.13	12.19±1.74	0.18±0.39
	Post	5.91±5.03	10.00±0.00	7.10±4.59	0.09±0.29
	Difference	2.73±5.50	0.45±2.13	-5.18±3.76	-0.09±0.29
Video-based group	Pre	5.71±5.14	9.29±2.67	12.84±1.81	0.07±0.27
	Post	9.29±2.67	8.64±3.46	9.36±5.34	0.07±0.27
	Difference	3.57±4.97	-0.64±2.41	-3.48±5.26	0.00±0.00
p-value		0.74	0.57	0.15	0.67

[1]Vertebral rotation assessed by the Nash-Moe method.

P-value: difference between the leaflet-based and the video-based groups.

and the video-based group showed significant improvement from 12.84±1.81° to 9.36±5.34° (p=0.019) (Table 2).

Leaflet-based group showed an improvement in rotational degree from 0.18 to 0.09, although this change was not statistically significant (p=0.157). In contrast, the rotational degree in the video-based group remained unchanged at 0.07 before and after the intervention.

DISCUSSION

The results of this study indicate that both leaflet-based and video-based core stabilization exercises improve Cobb angle and enhance endurance in maintaining the bird-dog position in patients with JIS. Given the lack of significant differences between the two groups, it is important to provide patients with JIS the option of using either method to ensure proper performance of core stabilization exercises. To the best of our knowledge, this is the first study to compare the effectiveness of leaflet-based versus video-based core stabilization exercises in improving scoliosis in patients with JIS.

Core muscles, essential for almost all kinetic chains in the body, play an important role in the stabilization and movement of body segments. These muscles help to maintain posture and enable the movement of limbs against gravity, and contribute to smooth central movement. It is known that the lumbar multifidus and deep paraspinal muscles are susceptible to imbalances. Individuals with IS often show signs of fatty infiltration and muscle atrophy in these areas.[12-16] A previous study of JIS indicated that early conservative treatment, starting in childhood, could positively influence the natural progression of JIS, with the goal of keeping the curve as far as possible from the threshold for surgery. [17] In patients with IS, impaired neuromuscular control of the core muscles and postural asymmetry reduce trunk motor control and decrease postural stability during movement.[18] Core stabilization exercises are known to improve neuromuscular control and strengthen the core muscles. Previous studies have reported that performing core stabilization exercises in patients with IS can reduce lumbar apical vertebral rotation and alleviate pain.[19]

Core muscles are classified into local muscles, such as the multifidi and transverse abdominis, and global muscles, such as the erector spinae, quadratus lumborum, obliques, and rectus abdominis. Core stabilization exercises consist of stability and mobility training for both the local and global muscles. According to previous studies, the amplitude of electromyography for the multifidus and erector spinae increases during the bird-dog exercise, while the amplitude of the multifidus, erector spinae, and rectus abdominis increases during the Superman exercise.[20] Thus, both bird-dog and Superman exercises activate local and global muscles. Additionally, unlike the symmetrical movements of the upper and lower limbs in the Superman exercise, the bird-dog exercise involves asymmetrical movements.[21] In this study, bird-dog and Superman exercises engage local and global core muscles, incorporating both symmetric and asymmetric movements. Although there was no statistically significant improvement observed in the Superman posture task, this result may be partially explained by a potential ceiling effect. Since participants were limited to a maximum of 10 seconds for this posture, those who already performed near this cap at baseline may have had little room for measurable improvement. This comprehensive approach likely contributed to the observed improvements in the Cobb angle among children with JIS.

A previous study showed that exercise compliance correlates with the regression effect in children with IS.[22] Traditionally, leaflets have been used to improve exercise compliance for self-regulated exercises, such as the core stabilization exercises used in this study; however, they have often been considered monotonous.[23] YouTube videos may offer a more engaging alternative to increase motivation for patients with JIS performing core stabilization exercises. In this study, unexpectedly, there was no difference in the improvement of JIS between the leaflet-based and the video-based groups. A previous study evaluated the adherence to self-regulated exercise using leaflets and exergames in older adults, and unexpectedly, the leaflet group showed superior adherence, enjoyment, and motivation compared to the exergame group.[23] Exergames or YouTube videos require specific devices and active engagement with content, while leaflets offer easy access, as they only need to be placed in a visible location. According to previous studies on participation in web-based fitness through YouTube videos during the COVID-19 pandemic, exercise using YouTube videos initially showed high participation rates; however, this participation declined sharply after the first week.[24] This may explain why there was no difference in the effectiveness of core stabilization exercises between the video-based and the leaflet-based groups.

Limitations

This study has certain limitations. First, there was a substantial difference in sample sizes between the leaflet-based and video-based groups, with 22 and 14 participants, respectively. This imbalance may have reduced the statistical power of certain analyses and increased the risk of type II error. This imbalance could have limited our ability to detect statistically significant differences, particularly in outcomes with small effect sizes. Future studies with more balanced group allocations are recommended to improve statistical validity. Another limitation is the gender imbalance between groups, which was not controlled for in the analysis. As sex differences can influence physical performance and response to intervention, this imbalance may have affected the outcomes. Future studies should consider stratifying or adjusting for sex to ensure more accurate interpretation of the results. To evaluate the effectiveness of core stabilization exercises, it is necessary to assess adherence, enjoyment, and motivation in both the leaflet-based and video-based groups. However, this study did not investigate adherence to each exercise. In future studies, exercise adherence could be assessed using daily exercise logs completed by participants or caregivers, or mobile applications that provide reminders and record usage data. Additionally, periodic follow-up through phone or video calls could help monitor engagement and verify compliance.

CONCLUSION

This study demonstrated that both the leaflet-based and video-based core stabilization exercises were effective for JIS, with no significant difference between the two groups. Preventing the progression of JIS is crucial, and it is necessary to develop and refine methods that are easy for juvenile children to understand and follow, while also encouraging consistent participation and motivation. Although it was not possible to determine how consistently participants performed the exercises three times a day over the 6 months using the leaflet or YouTube video, simply recommending core stabilization exercises appears to have had a certain degree of effect. Based on these findings, future RCT studies are warranted to evaluate the impact of home exercise on scoliosis more precisely.

Key Points

Question Does leaflet- or video-based instruction improve the effectiveness of home core stabilization exercises in juvenile idiopathic scoliosis (JIS)?

Findings In this retrospective study of 36 children with JIS and a Cobb angle of 10–20º, participants performed home

core stabilization exercises for 6 months guided either by a leaflet (n=22) or a video (n=14). Both groups showed significant improvements in Cobb angle and endurance in the bird-dog posture after the intervention, but there were no significant differences between the leaflet-based and video-based groups.

Meaning Both leaflet- and video-based instructions are effective for improving Cobb angle and endurance in JIS patients, suggesting that either method can be recommended for home core stabilization exercises.

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Author contributions

Conceptualization: JH Suh.
Data acquisition: JH Suh.
Design of the work: JH Suh.
Data analysis: JH Suh.
Project administration: JH Suh.
Interpretation of data: JH Suh.
Writing – original draft: JH Suh.
Writing–review&editing: JH Suh.

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