KTO Karatay Üniversitesi Sağlık Bilimleri Dergisi ISSN: 2717-8501 KTO Karatay University Journal of Health Sciences
Geliş Tarihi:09/02/2025 Kabul Tarihi:5/03/2025
Yıl 2025 | Cilt 6| Sayı 1 **Araştırma Makalesi/ Research Article** DOI: 10.59244/ktokusbd.1636181

Short-Term Effect of Schroth Method on Pain, Body Awareness, and Quality of Life in Adolescent Individuals with Idiopathic Scoliosis: A Controlled Trial

Adolesan İdiyopatik Skolyozlu Bireylerde Ağrı, Beden Farkındalığı ve Yaşam Kalitesi Üzerine Schroth Yönteminin Kısa Dönem Etkisi: Kontrollü Bir Çalışma

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ÖZET

Giriş: Skolyoz tedavisinde düzenli takiplerle izlem, cerrahi, korse kullanımı, elektriksel stimülasyon ve egzersiz yaklaşımları yaygın olarak kullanılmaktadır. Schroth yönteminin adolesan idiyopatik skolyoz (AİS) hastalarında ağrı üzerindeki etkinliği hâlâ netlik kazanmamıştır. Bu çalışma, 10-18 yaş arası adölesan İS'li bireylerde Schroth egzersizlerinin ağrı, beden farkındalığı ve yaşam kalitesi üzerine etkilerini incelemeyi amaçlamıştır.**Yöntem:** Çalışmaya İS tanısı almış toplam 31 birey dâhil edilmiştir. Çalışma grubunun (n=16) yaş ortalaması 14,06 yıl, kontrol grubunun (n=15) yaş ortalaması ise 15,07 yıl olarak belirlenmiştir. Çalışma grubuna 6 hafta boyunca haftada 3 gün, günde 1 saat Schroth egzersizleri uygulanmış; kontrol grubuna ise geleneksel egzersiz programı verilmiştir. Ağrı şiddeti Görsel Analog Skala (GAS), basınç-ağrı eşiği algometre ile, beden farkındalığı Beden Farkındalık Anketi (BAQ), yaşam kalitesi ise Skolyoz Araştırma Derneği-22 (SRS-22) ölçeği ile değerlendirilmiştir.**Bulgular:** Her iki grupta da ağrı şiddetinde ve basınç-ağrı eşiğinde istatistiksel olarak anlamlı iyileşmeler görülmüştür. Ancak, 6 hafta sonunda çalışma grubunda ağrı şiddetinde daha belirgin bir azalma ve ağrı eşiğinde daha büyük bir artış saptanmıştır ($p<0,05$). BAQ puanlarında her iki grupta da anlamlı artış gözlenmiş, grup içi karşılaştırmalarda beden farkındalığında önemli iyileşmeler tespit edilmiştir. Ancak gruplar arası farklar istatistiksel olarak anlamlı değildir. SRS-22 puanları her iki grupta da artış göstermiştir; ancak tedavi sonrası çalışma grubunda özellikle ağrı ile ilişkili yaşam kalitesi, tedavi memnuniyeti, alt toplam ve toplam SRS-22 skorlarında anlamlı düzeyde daha fazla artış görülmüştür ($p<0,05$).**Sonuç:** Schroth yönteminin kısa süreli (<6 ay) yoğun uygulanması, adolesan İS'li bireylerin tedavisinde ağrı ve yaşam kalitesi üzerinde olumlu terapötik etkiler göstermiştir.

Anahtar Kelimeler: Adolesan İdiyopatik Skolyoz, Ağrı, Beden Farkındalığı, Yaşam Kalitesi, Schroth Terapisi

ABSTRACT

Introduction: Monitoring with regular follow-ups, surgery, bracing, electrical stimulation, and exercise modalities has been widely used in the treatment of scoliosis. The effectiveness of the Schroth method for pain in adolescent patients with idiopathic scoliosis (AIS) remains unclear. This study aimed to investigate the effects of Schroth exercises on pain, body awareness, and quality of life in adolescent individuals (10-18 years) with IS. **Methods:** The study included 31 individuals diagnosed with IS, with an average age of 14.06 years in the study group (n=16) and 15.07 years in the control group (n=15). Schroth exercises were prescribed to the study group for 1 h, 3 times a week, for 6 weeks, while the control group performed traditional exercises. Pain severity was evaluated using the Visual Analog Scale, pressure-pain threshold with an algometer, body awareness with the Body Awareness Questionnaire (BAQ), and quality of life using the Scoliosis Research Society-22 (SRS22). **Results:** Both groups showed statistically significant improvements in pain severity and pressure-pain threshold, while the study group showed a further decline in pain severity and increase in pain threshold after 6 weeks ($p<0.05$). The BAQ scores improved significantly in both groups ($p<0.05$), with within-group comparisons revealing a notable increase in body awareness scores for both the Schroth and control groups. However, the between-group differences were not statistically significant. SRS22 scores were improved in both groups, while pain-related quality of life, treatment satisfaction, and subtotal and total SRS22 scores were significantly better in the study group after treatment ($p<0.05$). **Conclusions:** The short-term (<6 months) intensive application of the Schroth method demonstrated positive therapeutic effects on pain and quality of life in the treatment of adolescent individuals with IS.

Keywords: Adolescent Idiopathic Scoliosis, Chronic Pain, Body Awareness, Quality of Life, Schroth Therapy.

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INTRODUCTION

Idiopathic scoliosis (IS), whose etiology and biomechanical mechanism are still unclear, constitutes 70% of spinal deformities and approximately 80% of structural scoliosis (Yaman & Dalbayrak, 2014). IS is known as adolescent IS (AIS) in the 10-18-year age group, and its prevalence varies between 0.47% and 5.2% depending on ethnic and geographical characteristics (Konieczny et al., 2013). The prevalence of AIS in Turkey is 2.73% in Turkey (Cilli et al., 2009).

Monitoring with regular follow-ups, surgery, bracing, traction, casting, electrical stimulation, and exercises has been widely used in the treatment of scoliosis. It has been reported that early treatment slows down or completely stops the progression of the deformity and corrects the already developed deformity, with some exceptions (Ramirez & Eberson, 2017). The Schroth method, developed by Katherina Schroth in 1921, is a three-dimensional exercise method for the treatment of scoliosis. The exercises are organized asymmetrically and specific-to-scoliosis of the individual, accompanied by rotational breathing exercises to provide angular correction (Weiss et al., 2022). Evidence has already been published showing the effectiveness of this method on Cobb angle, vital capacity, muscular endurance, postural alignment, and quality of life (QoL) (Kim & Hwangbo, 2016).

Although there are publications reporting IS as a painless condition, a study reported an incidence of back pain of 53% without any underlying pathological condition in addition to scoliosis in these individuals (Theroux et al., 2017). In adolescent individuals with IS, pain is not defined as a primary complication (Theroux et al., 2017), but it is still among the complaints reported by individuals. It has been stated that the localization of pain is mostly on the scapula on the convex side and around the gibbosity (Weinstein, 2019). While the general treatment approach for pain in IS is usually surgical treatment in the literature (Chan et al., 2017), the effectiveness of conservative treatment on pain, which includes three-dimensional exercises in addition to Pilates, spinal stabilization, and brace treatment has been shown in a limited number of studies, both in adolescents and adults (Zapata et al., 2017). However, the effectiveness of the Schroth method on pain in adolescents with IS remains unclear.

Body awareness is an important component of correct postural alignment in IS. The only study that has investigated body awareness in individuals with adolescent IS reported improvements in body symmetry with basic body awareness therapy (Yagci, Ayhan, et al., 2018). However, the effects of different conservative treatment methods on body awareness in these individuals have not been extensively studied.

Scoliosis negatively affects self-confidence. Additionally, limited physical activity, musculoskeletal pain, poor body perception, and psychological or social difficulties can negatively impact daily life and reduce quality of life in individuals with IS. (Choi et al., 2011). Different therapeutic techniques, such as spinal stabilization exercises and scoliosis-specific exercises, have positive effects on QoL in adults with IS (Lebel & Lebel, 2016). While spinal stabilization and scoliosis-specific exercises have demonstrated positive effects on QoL in adults with IS, studies evaluating these effects in adolescents remain limited.

The aim of the current study was to investigate the effectiveness of a 6-week treatment with the Schroth method in comparison to traditional exercises on pain, body awareness, and QoL in AIS.

MATERIALS AND METHODS

Design and participants

This controlled study (ClinicalTrials.gov identifier number: NCT04689295 / 01.07.2019) was conducted in a special spine health center between July 2019/May 2021. Ethics committee approval was obtained from the Non-Pharmaceuticals and Non-Medical Devices Research Ethics Committee (decision number: 2019/0041). After a thorough verbal explanation of the study details, written consent was obtained from all participants or their parents for both participation in the study and publication of information/image identification in an online open-access format. This study was conducted in accordance with the principles of the Declaration of Helsinki.

Adolescent individuals who were diagnosed with IS between 10-18 years of age had C- or S-type scoliosis with a primary curve angle between 25-40 degrees (moderate curve) according to the Cobb method (Cobb, 1948), who were not prescribed a brace (which can affect pain severity), had pain due to scoliosis in the back/low-back area, and who had not undergone any exercise therapy after diagnosis were included in the study. The exclusion criteria were a history of any injury in the musculoskeletal system within the previous 6 months, neurological, orthopedic, or cardiopulmonary disease other than scoliosis, and a history of surgery related to scoliosis.

Power analysis was conducted using G*Power software (Ver. 3.0.10, Franz Faul, Universität Kiel, Germany) based on preliminary data from eight individuals. A sample size of 28 (14 per group) was determined to achieve a study power of 80% with a Type 1 error rate of 5% and a 95% confidence interval. The final analysis included 31 participants, with additional individuals considered for potential data loss. A flow chart of the study is presented in Figure 1.

After recording the demographic features of the individuals, the following assessments were performed in both groups before and after the treatment protocols.

Assessments

Pain

Pain was assessed using subjective and objective methods. For subjective pain assessment, a visual analog scale (VAS), which has been reported to be valid and reliable, was used. The VAS consists of a 10-cm line that measures pain intensity. Individuals were asked to mark the

severity of the pain they experienced on the line ["0" (no pain)-"5" (moderate pain)-"10" (severe pain)] under three different conditions: at rest, in daily life, and during exercise (Begum & Hossain, 2019).

Objective pressure pain threshold measurement was performed using a Wagner algometer (CT06836, Greenwich, England) (Potter et al., 2006). To accurately measure the pressure pain threshold, an algometer was introduced, and training was provided to all individuals. The feeling of pressure was introduced to the individuals and they were asked to say "stop" when they felt the pain. Initially, participants were asked to describe the area of pain. In accordance with the literature (Balagué & Pellisé, 2016), the pain zone was detected lateral to the apical vertebra of the primary curve gibbosity. Pressure was applied to the pain area three times at intervals of 5 s, and the value read on the device at the moment the individuals felt pain and said "stop" was recorded in Newtons. The mean of the measurements was recorded as the pressure pain threshold for the painful area.

Body Awareness

Body awareness was evaluated using the Body Awareness Questionnaire (BAQ), with reference to both its Turkish and original versions(Shields et al., 1989),(Karaca & Bayar, 2021). To determine the level of normal or abnormal sensitivity to body composition, the BAQ consists of four subgroups, namely, changes in body process, sleep-wake cycle, prediction at the onset of the disease, and body response prediction, and 18 expressions, such as, "I understand the difference in my body's reactions to various foods," "I predict beforehand that I will have the flu," and, "I notice my specific body reactions in a state of extreme hunger". Individuals were asked to rate each statement from 1 (not correct for me) to 7 (completely correct for me). The total score on the questionnaire ranges from to 18-126, with higher scores indicating more body sensitivity (Karaca & Bayar, 2021).

Quality of Life (QoL)

Disease-related QoL was assessed using the Turkish version of the Scoliosis Research Society-22 (SRS22) outcome questionnaire developed by SRS (Alanay et al., 2005), also cited from its original publication (Asher et al., 2003). The scale consists of 22 questions and five sub-dimensions: pain, self-image, spinal functions, mental health, and treatment satisfaction. All these sections were evaluated separately and/or by summing all the questions under a total score. Scores were calculated by assigning a value between 1 and 5 to each question. Each section was calculated within itself, and a mean value was obtained for each section. In the sub-total, the average of the sections, except for the treatment with satisfaction section, was calculated for the sub-total, and the average of five sections was calculated as the total score.

Accordingly, the lowest total score of the survey was 1 and the highest total score was 5, with higher scores indicating better QoL.

Treatment protocol

In the study group, individuals received Schroth exercises under the supervision of a trained physiotherapist in the Schroth treatment (4 years of experience after completing the Schroth training given by ISST) for a total of 18 60-minute sessions, 3 days a week, for 6 weeks. On the remaining days of the week, the same exercises were also prescribed as a home exercise program for at least 30 min and followed up via video recordings and photos taken by the family. Teleconferences and diaries were conducted weekly to follow the home program, and participant adherence was monitored. The compliance rate for the home exercise program was determined to be approximately 95% based on self-reported logs and parental feedback. Exercise compliance was determined based on the individual's curve type and nature of the curve. The sessions started with basic corrections and rotational breathing exercises. After each subject successfully performed these exercises, the following sessions were performed by combining Schroth's fundamental 15 exercises (ranging from basic to advanced) with basic corrections and rotational breathing exercises. The treatment sessions for each subject progressed individually, considering the successful completion of an exercise and the individual's physical capacity in accordance with the type and structure of the curve.

In the control group, a standard traditional exercise program was adapted to each individual's curve pattern and applied for six weeks. The individuals were trained for 1 h under the supervision of a physical therapist once a week, followed by a home program for at least half an hour a day for the rest of the week. The traditional exercise program for scoliosis includes breathing exercises, postural training, exercises for spinal flexibility, stretching especially for the muscles on the concave side of the curve, and general strengthening exercises specific to the major muscle groups of the trunk, pelvis, and shoulder girdle on the convex side of the curve (Monticone et al., 2014). To prevent any variability in the treatment application of the control group, the physiotherapist performed a suitability check for exercise treatment at the end of the supervised session each week during the study period. The application purposes and pictures of the exercises are shown in Table 1 and Figure 2.

Table 1. Schroth and traditional exercises performed in the study and their application purposes

Schroth Exercises	Objectives	Traditional Exercises	Objectives
1. Muscle Cylinder	Thoracic derotation, deflection of lumbar gibbosity	1. Breathing exercises	Increasing thoracic expansion
2. Between two poles	Pelvis, shoulder levels, and head correction	2. Posture exercises	Providing postural correction
3. Big bow	Thoracic flexion and elongation of the spine	3. Flexibility exercises	Elongation of the whole spine
4. St. Andrew Cross and Side-hanging	Stretching of the thoracic concavity and pelvic correction	4. Stretching exercises	Stretching the concavity of the curve
5. Chest Twister	Pelvic correction	5. Strengthening exercises	Strengthening the muscles at the convex side of the curve
6. Muscle cylinder kneeling	Lumbar lateral deflection and derotation		
7. Foot under a bar	Lateral deflection, derotation, and extension of the lumbar/thoracolumbar curvature		
8. Shoulder counter traction	Shoulder counter traction to correct thoracic curvature		
9. Shoulder counter traction in side position	Shoulder counter traction training		
10. Moving ribs	Posterior-anterior active mobilization of lumbar/thoracolumbar extension		
11. Kneeling on one knee	Correction of lumbar/thoracolumbar curvature using pelvic tilt		
12. Prominent hip exercise	Pelvic correction training in standing posture		
13. Sail	Stretching the thoracic concavity		
14. Sitting on ball	Ensuring control of corrections on moving ground		
15. Schroth gate	Ensuring the continuity of corrections in dynamic conditions		

Statistical Analysis

Version 21.0 of SPSS was used for data analysis. Normality was assessed with the Shapiro-Wilk test. Parametric tests (Independent sample t-test, dependent sample t-test) were used for normally distributed variables, while non-parametric tests (Mann-Whitney U, Wilcoxon signed-rank) were applied otherwise. The chi-square test compared qualitative variables. Statistical significance was set at $P<0.05$.

Sample size was determined using G*Power (Ver. 3.0.10, Franz Faul, Universität Kiel, Germany). A pilot study with 10 volunteers (5 per group) informed power analysis, requiring at least 14 participants per group (α=0.05, power=0.90, effect size=0.58). The study included 31 participants, accounting for possible data loss (Reeves & Gaus, 2004).

The study followed CONSORT guidelines for nonrandomized trials.

RESULTS

Of the 54 adolescents screened for eligibility, 35 met the inclusion criteria, and 31 completed the study (Figure 1). Participants in both groups were similar in terms of demographic characteristics, including age (14.06 years in the study group vs 15.07 years in the control group), BMI (Body Mass Index) (18.15 kg/m2 in the study group vs 17.32 kg/m2 in the control group), sex (Female n (%): 12 (75) in the study group vs. female n (%): 12 (80) in the control group), and baseline Cobb angle (30.40 in the study group vs 29.70 in the control group). No significant differences were observed between the groups at baseline for any of the outcome measures, ensuring comparability between the Schroth and the control groups. The groups were homogenous in terms of age, BMI, and sex (p>0.05) (Table 2).

Table 2. Demographic characteristics of the individuals (n=31)

	Study Group (n= 16)	**Control Group (n=15)**	***p***
Age (years)	14.06±2.20	15.07±1.83	0.18
BMI (kg/m^2)	18.15±2.80	17.32±1.50	0.31
Gender	Female: 12 (75.0%) Male: 4 (25.0%)	12 (80.0%) 3 (20.0%)	0.74

Independent sample t test for numeric variables, Chi-square test for nominal variable.

Pain

In the comparison of baseline VAS values, no difference was found between the groups (p>0.05), whereas the pain threshold measured by an algometer was statistically higher in the control group at baseline (p=0.001). Both the study and control groups showed statistically significant improvements in pain severity and pain threshold after 6 weeks of treatment (p<0.05). However, in the between-group comparison, a statistically significant difference was found in terms of pain severity and pain threshold in favor of the study group (p<0.05) (Table 3).

Table 3. Pain results of the individuals (n=31)

Assessments	Within-Groups Comparisons		Between Groups Comparison
	Study Group (n=16) Mean±SD	**Control Group (n=15) Mean±SD**	*p*
VAS-Resting			
Baseline	5.31±2.02	4.47±1.35	<0.001*
6th week	0.94±0.93	3.86±1.06	
p	<0.001*	0.03*	
VAS-Daily life			
Baseline	4.87±1.78	4.60±0.74	
6th week	1.44±0.81	3.60±0.91	<0.001*
p	<0.001*	0.004*	
VAS-Exercise			
Baseline	5.87±2.12	5.27±0.80	
6th week	1.31±1.14	4.40±1.24	<0.001*
p	<0.001*	0.006*	
Pressure-pain threshold (N)			
Baseline	5.56±1.51	7.86±2.10	
6th week	7.67±1.81	8.65±2.14	0.002*
p	<0.001*	0.01*	

*p<0.05, VAS: Visual Analog Scale, N: Newton.

Dependent sample t test for within group comparison, Independent sample t test for between group comparison (Pain Threshold). Wilcoxon signed rank test for within group comparison, Mann Whitney U Test for between group comparison (Visual Analog Scale).

Body Awareness

The baseline BAQ values of individuals in the control group were approximately 13 points higher than those in the control group (p=0.008). Although the control group was superior to the study group in the within-group comparison (p<0.05), there was no difference in the between-group comparisons (p>0.05) (Table 4).

Table 4. Body awareness and quality of life results of the individuals (n=31)

Assessments	Within-Groups Comparisons		Between Groups Comparisons
	Study Group (n=16) Mean±SD	**Control Group (n=15) Mean±SD**	*p*
BAQ			
Baseline	94.81±14.26	107.47±4.64	
6th week	95.06±14.14	108.60±3.96	0.1
p	0.4	0.03*	
SRS22-Pain			
Baseline	3.51±0.22	3.55±0.19	
6th week	4.09±0.16	3.75±0.22	<0.001*
p	<0.001*	0.002*	
SRS22-Self image			
Baseline	3.03±0.22	2.64±0.38	
6th week	3.30±0.15	2.81±0.35	0.3
p	0.003*	0.006*	

Table 4 (Continue). Body awareness and quality of life results of the individuals (n=31)

SRS22-Functions			
Baseline	4.06±0.50	3.68±0.41	
6th week	4.41±0.34	3.93±0.26	0.3
p	<0.001*	0.004*	
SRS22-Mental Health			
Baseline	3.96±0.17	3.79±0.31	
6th week	4.05±0.15	3.85±0.32	0.7
p	0.02*	0.02*	
SRS22-Treatment Satisfaction			
Baseline	NA	NA	
6th week	4.62±0.38	3.47±0.30	<0.001*
p	----	----	
SRS22-Subtotal			
Baseline	3.64±0.17	3.41±0.16	
6th week	3.98±0.13	3.59±0.16	0.001
p	<0.001*	0.001*	
SRS22-Total			
Baseline	2.91±0.13	2.73±0.13	
6th week	4.02±0.11	3.56±0.15	<0.001*
p	<0.001*	0.001*	

*p<0.05, BAQ: Body Awareness Questionnaire, SRS22: Scoliosis Research Society 22, Wilcoxon signed rank test for within group comparison, Mann Whitney U Test for between group comparison.

Quality of Life (QoL)

There were significant differences between the groups in the SRS22 dimensions and total score at the baseline evaluations, except for Pain and Mental Health dimensions (SRS Spinal functions p=0.03; SRS22 Self-image p=0.003; SRS22 Sub-total p=0.002; SRS22 Total p=0.002). In the within-group comparison, both groups showed statistically significant improvements after six 6-week treatments (p<0.05). Pain-related QoL, treatment satisfaction, and subtotal and total SRS22 scores were significantly better in the study group (p<0.05) (Table 4)

DISCUSSION

In this study, we compared the effects of Schroth and traditional exercises on pain, body awareness, and quality of life (QoL) in adolescents with idiopathic scoliosis (IS) and found that both 6-week treatments effectively reduced pain, increased pain threshold, and improved pain-related QoL. However, the Schroth method showed superior results compared to traditional exercises. Interestingly, improvement in body awareness was observed only in the traditional exercise group. Although both treatments enhanced QoL across all subdimensions, subtotal, and total scores, the Schroth method was associated with higher treatment satisfaction and pain-related QoL, which was reflected in the subtotal and total scores. Thus, the findings suggest that the Schroth method outperforms traditional scoliosis treatments in terms of improving QoL.

Regarding demographic characteristics, consistent with the literature indicating a higher prevalence of IS in females (Konieczny et al., 2013), 77% of the participants in this study were female. Additionally, the body mass index (BMI) of the study and control groups was consistent with previous reports, which described normal BMI results for individuals with IS based on World Health Organization standards (Negrini et al., 2015).

Previous studies have reported positive treatment outcomes with the Schroth method for IS, such as curve angle improvement, increased vital capacity, and enhanced postural alignment (Ceballos-Laita et al., 2023). Although pain is less frequently reported in adolescents with IS than in adults, evidence suggests that adolescents with scoliosis experience more pain than their healthy peers. For example, Théroux et al. found that pain in adolescents with IS was often localized around the apex of the primary curve, and the findings of this study were consistent with that observation (Théroux et al., 2017). In this study, both the Schroth and traditional exercise groups reported moderate pain at baseline, with significant improvements in pain severity and threshold after the 6-week intervention. However, the Schroth exercises led to substantial improvements in pain reduction and pain thresholds. The benefits of the Schroth method, such as enhanced thoracic expansion, better posture, reduced curve severity, and improved muscular balance (Kastrinis et al., 2022), likely played a key role in alleviating pain. Additionally, exercise is known to increase nitric oxide production, which can elevate pressure-pain thresholds (Arefirad et al., 2022). This physiological response may help explain the reduction in pain and increase in pressure-pain thresholds observed in this study. Future studies are needed to evaluate whether extended Schroth exercise programs could contribute to further pain relief.

Body position perception in space is achieved through the vestibular, visual, and proprioceptive neural pathways. Correct body perception depends on the proper input orientation and postural adaptation (Takakusaki, 2017). Studies have reported positive outcomes of incorporating body awareness therapy into conservative IS treatments (Yagci, Ayhan, et al., 2018; Yagci, Yakut, et al., 2018). In this study, traditional exercises were more effective in improving body awareness than Schroth exercises. Two factors may explain this outcome. The primary aim of the Schroth method is to reduce curve severity rather than directly enhance body perception, and traditional exercises focus more on postural alignment. Evidence from previous research indicates that long-term Schroth therapy can significantly improve the self-image of adolescents with IS. Moreover, targeted body awareness therapies may need to be integrated with the Schroth method to effectively address this issue.

IS is associated with pain, poor body image, and reduced social functioning, which can negatively impact QoL (Wang et al., 2014). Although few studies have evaluated QoL following scoliosis rehabilitation programs, those that have generally reported improvements. For instance, combining Schroth and Pilates exercises or engaging in active correction programs over extended periods has shown positive effects on the QoL of individuals with IS (Rrecaj-Malaj et al., 2018). Schreiber et al. found that a 6-month Schroth program significantly improved QoL and self-image compared with standard care (Schreiber et al., 2014). In this study, significant QoL improvements were observed with both Schroth and traditional exercises over six weeks, as measured by the SRS-22 (Scoliosis Research Society-22) questionnaire. In particular, the Schroth group showed better treatment satisfaction and pain-related QoL outcomes, which contributed to higher overall scores.

While both the Schroth and traditional exercise methods produced improvements in pain, body awareness, and QoL, it is important to note that traditional exercises may not fully address the specific needs of adolescents with idiopathic scoliosis (IS). Traditional exercises typically focus on general strengthening and stretching, but they lack the tailored approach required to correct postural abnormalities or improve curve alignment in IS patients. This limitation suggests that traditional exercises may not be as effective in managing the unique characteristics of IS, such as asymmetrical posture and spinal deformities. In contrast, the Schroth method provides a more specialized intervention, targeting spinal alignment and postural correction, which may explain its superior outcomes in pain reduction and QoL improvement. Therefore, while traditional exercises have some benefits, their effectiveness in treating IS may be limited compared to more specialized methods like Schroth.

Despite its strengths, this study had several limitations. The small sample size and short intervention period limited the generalizability of the findings. The absence of a no-treatment control group made it challenging to distinguish the effects of the Schroth method from the natural progression of the condition. Additionally, the reliance on self-reported measures of pain, body awareness, and QoL while providing valuable patient insights may lack objectivity.

CONCLUSION

This study suggests that the Schroth method is an effective conservative treatment for adolescents with moderate idiopathic scoliosis, yielding significant improvements in pain, QoL, and self-image. While both the Schroth method and traditional exercises enhanced body awareness, the Schroth exercises provided superior pain relief and patient satisfaction. These findings underscore the value of Schroth-based exercises as part of a comprehensive scoliosis management strategy, and highlight the need for additional research to evaluate their long-term effects.

Conflict of Interest
The authors declare no conflict of interest regarding the publication of this study.

Financial Support Statement
The research did not receive financial support from any organization.

Author Contributions
Research Idea/Concept: FÇ, NB, İAG
Research Design: FÇ, NB, İAG
Supervision/Consultancy: FÇ, NB, İAG
Data Collection and/or Processing: FÇ, NB, İAG
Analysis and/or Interpretation of Data: FÇ, NB, İAG
Literature Review: FÇ, NB, İAG
Article Writing: FÇ, NB, İAG
Critical Review: FÇ, NB, İAG

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Alanay, A., Cil, A., Berk, H., Acaroglu, R. E., Yazici, M., Akcali, O., Kosay, C., Genc, Y., & Surat, A. (2005). Reliability and validity of adapted Turkish Version of Scoliosis Research Society-22 (SRS-22) questionnaire. *Spine*, 30(21), 2464-2468. https://doi.org/10.1097/01.brs.0000184366.71761.84

Arefirad, T., Seif, E., Sepidarkish, M., Mohammadian Khonsari, N., Mousavifar, S. A., Yazdani, S., Rahimi, F., Einollahi, F., Heshmati, J., & Qorbani, M. (2022). Effect of exercise training on nitric oxide and nitrate/nitrite (NOx) production: A systematic review and meta-analysis. *Frontiers in physiology*, 13, 953912. https://doi.org/10.3389/fphys.2022.953912

Asher, M., Lai, S. M., Burton, D., & Manna, B. (2003). The reliability and concurrent validity of the scoliosis research society-22 patient questionnaire for idiopathic scoliosis. *Spine*, 28(1), 63-69. https://doi.org/10.1097/00007632-200301010-00015.

Balagué, F., & Pellisé, F. (2016). Adolescent idiopathic scoliosis and back pain. Scoliosis and spinal disorders, 11, 1-15. *DOI:*10.1186/s13013-016-0086-7

Begum, M. R., & Hossain, M. A. (2019). Validity and reliability of visual analogue scale (VAS) for pain measurement. *Journal of Medical Case Reports and Reviews*, 2(11).

Ceballos-Laita, L., Carrasco-Uribarren, A., Cabanillas-Barea, S., Perez-Guillen, S., Pardos-Aguilella, P., & Del Barrio, S. J. (2023). The effectiveness of Schroth method in Cobb angle, quality of life and trunk rotation angle in adolescent idiopathic scoliosis: a systematic review and meta-analysis. EuropEan *Journal of physical and rehabilitation medicine*, 59(2), 228. https://doi.org/10.23736/S1973-9087.23.07654-2

Chan, P., Skaggs, D. L., Sanders, A. E., Villamor, G. A., Choi, P. D., Tolo, V. T., & Andras, L. M. (2017). Pain is the greatest preoperative concern for patients and parents before posterior spinal fusion for adolescent idiopathic scoliosis. *Spine*, 42(21), E1245-E1250. https://doi.org/10.1097/BRS.0000000000002147

Choi, J.-H., Oh, E.-G., & Lee, H.-J. (2011). Comparisons of postural habits, body image, and peer attachment for adolescents with idiopathic scoliosis and healthy adolescents. *Child Health Nursing Research*, 17(3), 167-173. https://doi.org/10.4094/jkachn.2011.17.3.167

Cilli, K., Tezeren, G., Taş, T., Bulut, O., Oztürk, H., Oztemur, Z., & Unsaldi, T. (2009). School screening for scoliosis in Sivas, Turkey. *Acta Orthop Traumatol Turc*, 43(5), 426-430. https://doi.org/10.3944/AOTT.2009.426

Cobb, J. (1948). Outline for the study of scoliosis. Instructional course lecture.

Karaca, S., & Bayar, B. (2021). Turkish version of body awareness questionnaire: validity and reliability study. *Türk Fizyoterapi ve Rehabilitasyon Dergisi*, 32(1), 44-50. https://doi.org/10.21653/tjpr.660186

Kastrinis, A., Koumantakis, G., Tsekoura, M., Nomikou, E., Katsoulaki, M., Theodosopoulos, E., Strimpakos, N., & Dimitriadis, Z. (2022). The Effect of Schroth Method on Postural Control and Balance in Patients with Adolescent Idiopathic Scoliosis: A Literature Review. Worldwide Congress on "Genetics, Geriatrics and Neurodegenerative Diseases Research",

Kim, K.-D., & Hwangbo, P.-N. (2016). Effects of the Schroth exercise on the Cobb's angle and vital capacity of patients with idiopathic scoliosis that is an operative indication. *Journal of physical therapy science*, 28(3), 923-926. https://doi.org/10.1589/jpts.28.923

Konieczny, M. R., Senyurt, H., & Krauspe, R. (2013). Epidemiology of adolescent idiopathic scoliosis. *Journal of children's orthopaedics*, 7(1), 3-9. https://doi.org/10.1007/s11832-012-0457

Lebel, A., & Lebel, V. A. (2016). Severe progressive scoliosis in an adult female possibly secondary thoracic surgery in childhood treated with scoliosis specific Schroth physiotherapy: Case presentation. *Scoliosis and spinal disorders*, 11(2), 67-71. https://doi.org/10.1186/s13013-016-0098-3

Monticone, M., Ambrosini, E., Cazzaniga, D., Rocca, B., & Ferrante, S. (2014). Active self-correction and task-oriented exercises reduce spinal deformity and improve quality of life in subjects with mild adolescent idiopathic scoliosis. Results of a randomised controlled trial. *European Spine Journal*, 23(6), 1204-1214. https://doi.org/10.1007/s00586-014-3241-y

Negrini, S., Minozzi, S., Bettany-Saltikov, J., Chockalingam, N., Grivas, T. B., Kotwicki, T., Maruyama, T., Romano, M., & Zaina, F. (2015). Braces for idiopathic scoliosis in adolescents. *Cochrane Database of Systematic Reviews* (6). https://doi.org/10.1002/14651858.CD006850.pub3

Potter, L., McCarthy, C., & Oldham, J. (2006). Algometer reliability in measuring pain pressure threshold over normal spinal muscles to allow quantification of anti-nociceptive treatment effects. *International journal of osteopathic medicine*, 9(4), 113-119. https://doi.org/10.1016/j.ijosm.2006.11.002

Ramirez, J. M., & Eberson, C. P. (2017). The role of rehabilitation in the management of adolescent idiopathic scoliosis. *RI Med J*, 100(11), 22-25.

Reeves, B., & Gaus, W. (2004). Guidelines for reporting non-randomised studies. *Complementary Medicine Research*, 11(Suppl. 1), 46-52. https://doi.org/10.1159/000080576

Rrecaj-Malaj, S., Hykolli, A., Lumi, S., & Murtezani, A. (2018). Quality of life in adolescent's idiopathic scoliosis before and after physical therapy: a preliminary study. *Sport Mont*, 16(2), 69-72. https://doi.org/10.26773/smj.180612

Schreiber, S., Parent, E. C., Hedden, D. M., Moreau, M., Hill, D., & Lou, E. (2014). Effect of Schroth exercises on curve characteristics and clinical outcomes in adolescent idiopathic scoliosis: protocol for a multicentre randomised controlled trial. *Journal of physiotherapy*, 60(4), 234. https://doi.org/10.1016/j.jphys. 2014.08.005

Shields, S. A., Mallory, M. E., & Simon, A. (1989). The body awareness questionnaire: reliability and validity. Journal of personality *Assessment*, 53(4), 802-815. https://doi.org/10.1207/s15327752jpa5304_16

Takakusaki, K. (2017). Functional neuroanatomy for posture and gait control. Journal of movement disorders, 10(1), 1. https://doi.org/10.14802/jmd.16062

Théroux, J., Le May, S., Hebert, J. J., & Labelle, H. (2017). Back pain prevalence is associated with curve-type and severity in adolescents with idiopathic scoliosis: a cross-sectional study. *Spine*, 42(15), E914-E919. https://doi.org/10.1097/BRS.0000000000001986

Theroux, J., Stomski, N., Hodgetts, C. J., Ballard, A., Khadra, C., Le May, S., & Labelle, H. (2017). Prevalence of low back pain in adolescents with idiopathic scoliosis: a systematic review. *Chiropractic & manual therapies*, 25, 1-6. https://doi.org/10.1186/s12998-017-0143-1

Wang, L., Wang, Y., Yu, B., Zhang, J., Shen, J., Qiu, G., & Li, Y. (2014). Relation between self-image score of SRS-22 with deformity measures in female adolescent idiopathic scoliosis patients. *Orthopaedics & Traumatology: Surgery & Research*, 100(7), 797-801. https://doi.org/10.1016/j.otsr.2014.06.014

Weinstein, S. L. (2019). The natural history of adolescent idiopathic scoliosis. *Journal of Pediatric Orthopaedics*, 39, S44-S46. https://doi.org/10.1097/BPO.0000000000001350

Weiss, H.R., Lenhert-Schroth, C., Moramarco, M., and Moramarco, K. (2022). Schorth Therapy, Advancements in Conservative Scoliosis Treatment, BP International. [3rd ed.]. https://doi.org/10.9734/bpi/mono/978-93-5547-321-9

Yagci, G., Ayhan, C., & Yakut, Y. (2018). Effectiveness of basic body awareness therapy in adolescents with idiopathic scoliosis: A randomized controlled study. *Journal of back and musculoskeletal rehabilitation*, 31(4), 693-701. https://doi.org/10.3233/BMR-170868

Yagci, G., Yakut, Y., & Simsek, E. (2018). The effects of exercise on perception of verticality in adolescent idiopathic scoliosis. *Physiotherapy theory and practice*, 34(8), 579-588. https://doi.org/10.1080/09593985.2017.1423429

Yaman, O., & Dalbayrak, S. (2014). Idiopathic scoliosis. *Turkish neurosurgery*, 24(5). https://doi.org/10.5137/1019-5149.JTN.8838-13.0

Zapata, K. A., Wang-Price, S. S., & Sucato, D. J. (2017). Six-month follow-up of supervised spinal stabilization exercises for low back pain in adolescent idiopathic scoliosis. *Pediatric Physical Therapy*, 29(1), 62-66. https://doi.org/10.1097/PEP.0000000000000325