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COMPARATIVE EFFECTIVENESS OF SCHROTH METHOD AND CONVENTIONAL EXERCISE ON POSTURAL ALIGNMENT AND PAIN IN ADOLESCENTS WITH IDIOPATHIC SCOLIOSIS: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Adolescent idiopathic scoliosis (AIS) is a three-dimensional spinal deformity often associated with postural misalignment, pain, and reduced quality of life. While conventional exercises are commonly prescribed, scoliosis-specific methods such as the Schroth Method may offer greater therapeutic benefits.

Objective:
To compare the effectiveness of the Schroth Method versus conventional exercise in improving posture and reducing pain in adolescents with AIS.

Methods: This randomized controlled trial (RCT) was conducted under the CONSORT guidelines over a six-month period, from April to October 2024, at Hayatabad Medical Complex (HMC-MTI), Peshawar. In this randomized controlled trial, adolescents aged 10–18 years with a Cobb angle of 10°–30° were allocated to either a Schroth-based

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exercise program or a conventional exercise group for 12 weeks. Primary outcomes included craniovertebral angle, thoracic kyphotic angle, and Numeric Pain Rating Scale scores. Secondary outcomes included Cobb angle, angle of trunk rotation, SRS-22 scores, and balance parameters. Measurements were taken at baseline, 6, 12, and 24 weeks.

Results: The Schroth group showed significantly greater improvements in postural alignment, Cobb angle reduction, and pain scores compared to the conventional group ($p < 0.05$). Improvements were sustained at 24-week follow-up.

Conclusion: The Schroth Method demonstrated superior effectiveness over conventional exercises in managing posture and pain in AIS. Incorporating scoliosis-specific exercise into conservative management may enhance patient outcomes.

INTRODUCTION

Scoliosis refers to a complex deformity of the spine in three planes. It is diagnosed by measuring the angle of curvature of the spine (a Cobb angle of at least 10°) in the frontal plane and the axial rotation in the horizontal plane, as well as being characterized by spinal deformities in the sagittal plane [1,2]. Adolescent idiopathic scoliosis (AIS) is a three-dimensional spine deformity. It is a structural, lateral, rotated curvature of the spine that arises in otherwise healthy children at or around puberty [3,4]. Although scoliosis can be diagnosed at any age, the majority of cases are detected during adolescence between 10 and 18 years [2,3,4,5]. Scoliosis is the most common adolescent deformity of the spine [6,7]. The International Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT) has estimated that the global incidence of adolescent idiopathic scoliosis (AIS) in pediatric population ranges from 0.93% to 12% [8]. Adolescent idiopathic scoliosis is a multifactorial disease with intrinsic and extrinsic alterations. However, about 80% of scoliosis cases present with idiopathic scoliosis of unknown etiology. Scoliosis is called idiopathic when no other underlying disease can be identified [9]. Inappropriate treatment of AIS can result in severe deformities of the trunk, back, and chest, disturbing the functional biomechanics of the body, limiting lung volume, and reducing physical capacity, work capacity, and quality of life [8]. Although scoliosis has long been thought to be a harmless condition, evidence indicates that people with scoliosis are more prone to experience back pain [10,11]. Scoliosis causes disability of varying severity and poses a high healthcare burden, particularly when patients require extensive surgical treatment [12,13]. Due to the complexity of the procedure, the surgical treatment for scoliosis involves a relatively high cost and risk of complications. Because the risks associated with mild and moderate scoliosis are very high, conservative treatment is preferred to stabilize the deformity and improve the quality of life.[14] Depending on the severity of the curve, treatment approaches consist of exercises, bracing, and surgery to prevent, correct, or halt the progression of the deformity caused by AIS [15]. A review of the literature revealed that exercises are often recommended to decrease progression, correct postural behavior, increase neuro-motor control of the spine, and to improve spine and thoracic flexibility, muscle strength, and elasticity [16]. Exercise

is almost always a part of the treatment plan for patients with AIS. In mild cases, exercise may be the main treatment, and it may serve as an adjunct in more severe cases [17].

Physiotherapeutic scoliosis-specific exercises (PSSE) represent an essential non-surgical approach Particularly the Schroth method. The Schroth method is a scoliosis-specific exercise approach commonly performed in scoliosis rehabilitation that uses postural, scoliosis-specific sensorimotor and breathing exercises [6, 18]. The treatment program consists of scoliotic posture correction with the help of exteroceptive and proprioceptive stimulations and mirrors, isometrics, and other exercises to lengthen or strengthen the asymmetrical muscles while maintaining a specific breathing pattern. Auto-correction is a basic component of the Schroth method, described as the patient's ability to decrease the spinal deformity using active postural realignment of the spine in three dimensions. The Schroth method is intended to improve the patient's motor control of their posture through the repetition of corrective movements with progressively less feedback [16, 19]. In several studies, the Schroth method was demonstrated to improve Cobb angles, slow curve progression, reduce the need for surgery, increase back muscle strength, and boost breathing function [7, 20]. For instance, a network meta-analysis published in 2024 encompassing 20 RCTs concluded that Schroth combined with bracing yielded the greatest improvements in Cobb angle, ATR, and QoL among non-operative treatments. Likewise, a 2023 meta-analysis highlighted moderate to large effect sizes favoring Schroth for trunk deformity reduction and QoL enhancement in AIS patients [21]

Postural dysfunctions often coexist with scoliotic curvature. Forward head posture, increased thoracic kyphosis, and impaired balance are commonly observed in AIS and can contribute to neck and back pain, affecting functional capacity and daily life [22]. For instance, cross-sectional analyses have revealed correlations between thoracic curvature and cervical spine misalignment, with resultant neck discomfort and functional limitations [23]. However, RCTs investigating how Schroth compares to conventional exercises in improving functional posture and alleviating pain are scarce [24]. Conventional exercise regimens for AIS typically involve general core stabilization, stretching, flexibility, and strengthening—not tailored to scoliotic curvature mechanics. While some benefit has been shown for general exercise in reducing low back pain and improving flexibility in adolescents, these improvements often fall short of outcomes seen with scoliosis-specific programs like Schroth, particularly regarding axial rotation correction and trunk symmetry [12,25]. Nonetheless, the relative effects of conventional versus Schroth programs on functional posture and pain relief are not well understood, and few studies have prioritized these as primary outcomes.

Considering these gaps, there is a pressing need for RCTs that compare Schroth against conventional exercise with a primary focus on posture and pain intensity, Therefore, the present study aims to evaluate the effectiveness of the Schroth method versus a conventional exercise protocol in improving postural alignment and pain intensity in adolescents with idiopathic scoliosis. We hypothesize that Schroth will yield greater improvements in cervical and thoracic alignment—as measured by cranio-vertebral angle and thoracic kyphosis—and greater pain reduction over a 12-week intervention compared with conventional exercise.

Methodology

This randomized controlled trial (RCT) was conducted under the CONSORT guidelines over a six-month period, from April to October 2024, at Hayatabad Medical Complex (HMC-MTI), Peshawar. Ethical

approval was obtained from the Graduate Committee (GC) of the Institute of Physical Medicine and Rehabilitation (IPM&R), Khyber Medical University (KMU), followed by final approval from the Advanced Studies and Research Board (ASRB). Written informed consent was obtained from all participants prior to enrollment.

Inclusion Criteria

- Adolescents aged 10–18 years
- Radiologically confirmed adolescent idiopathic scoliosis (AIS) with Cobb angle between 10° and 30°
- Risser sign ≤4 (skeletal immaturity)
- Ability to understand and follow instructions
- No prior scoliosis-specific exercise therapy in the last 6 months

Exclusion Criteria

- Non-idiopathic scoliosis (neuromuscular, congenital, syndromic)
- Previous spinal surgery or planned surgery during the trial period
- Severe cardiorespiratory disorders contraindicating exercise
- Cognitive or neurological impairments affecting participation
- Current participation in other clinical trials

Sample size was determined using G*Power software based on an expected moderate effect size (Cohen's d = 0.6) for improvement in cranio-vertebral angle (primary posture outcome) at 80% power and 5% significance level (two-tailed). A minimum of 23 participants per group was calculated. Allowing for a 15% dropout rate, 27 participants per group (total N = 54) will be recruited.

Participants who met the eligibility criteria after selection were assigned randomly to either the Schroth method group or the conventional exercise group by the use of a lottery method. In this method, patients were to select a piece of paper from a box. Group names (such as A or B) were written on the papers. Participants' allocation was done according to the group names that were written on the papers. The envelopes will be opened only after the baseline assessment. Due to the nature of the interventions, participants and therapists cannot be blinded. However, outcome assessors and data analysts will be blinded to group allocation to minimize measurement and analytical bias.

Interventions

1. Schroth Method Group

Participants were undergo a supervised Schroth physiotherapeutic scoliosis-specific exercise (PSSE) program delivered by a trained expert therapist.

Frequency & Duration: 3 sessions/week for 12 weeks; each session lasting 60 minutes.

Components:

- Three-dimensional auto-correction of spinal deformity
- Rotational angular breathing techniques
- Stabilization exercises in corrected posture
- Postural awareness and functional integration into daily activities
- Progression: Exercises will be progressed in complexity and resistance every 2 weeks based on individual tolerance and improvement.

2. Conventional Exercise Group

Participants will perform a general physiotherapy exercise program supervised by a licensed physiotherapist.

Frequency & Duration: 3 sessions/week for 12 weeks; each session lasting 60 minutes.

Components:

- Core stabilization exercises (planks, bridges)
- General spinal mobility exercises (cat-camel, trunk rotations)
- Flexibility and stretching exercises for hamstrings, hip flexors, and paraspinals
- Aerobic conditioning (light cycling and walking)

- No scoliosis-specific correction techniques will be applied.

The study assessed both primary and secondary outcome measures to evaluate the comparative effectiveness of the Schroth Method and conventional exercise in adolescents with idiopathic scoliosis. Primary outcomes included postural alignment—measured by cranio-vertebral angle (CVA) for forward head posture using digital photogrammetry, and thoracic kyphotic angle assessed with a flexible curve ruler and validated posture assessment software—and pain intensity, measured by the Numeric Pain Rating Scale (NPRS) at rest and during activity. Secondary outcomes were included: Cobb angle from standing full-spine radiographs, angle of trunk rotation (ATR) using a scoliometer, functional disability assessed by the Scoliosis Research Society-22 questionnaire (SRS-22), and balance performance evaluated through static posturography (center-of-pressure sway). Data was be collected at baseline, week 6, week 12, and week 24 (follow-up), with anthropometric measurements taken at baseline, week 12, and week 24; primary outcomes measured at all four time points; and secondary outcomes measured at baseline, week 12, and week 24. Statistical analysis was performed using SPSS v.27, with normality assessed via the Shapiro–Wilk test. Repeated-measures ANOVA was applied for normally distributed data to determine within- and between-group differences over time, while the Friedman test and Mann–Whitney U test was used for non-parametric data. Effect sizes will be reported using partial eta-squared, and an intention-to-treat (ITT) approach with last-observation-carried-forward will handle missing data. Statistical significance was set at $p < 0.05$. Ethical approval was obtained from the Institutional Ethics Committee with informed consent from participants and parental consent. The trial was prospectively registered on ClinicalTrials.gov, and all data were anonymized and stored securely. It is hypothesized that the Schroth group will show greater improvements in postural alignment measures and pain reduction compared to the conventional exercise group after 12 weeks, with sustained benefits at the 24-week follow-up

Result

A total of 54 participants meeting the inclusion criteria were randomized equally into the Schroth group (n = 27) and the Conventional exercise group (n = 27). All participants completed the 12-week intervention, and 51 participants (94.4%) completed the 24-week follow-up (one dropout in Schroth, two in the conventional group due to relocation). No adverse events were reported.

Table 1. Baseline Characteristics of Participants

Variable	Schroth Group (n=27) Mean ± SD	Conventional Group (n=27) Mean ± SD	p-value
Age (years)	14.8 ± 1.6	14.9 ± 1.5	0.81
Female (%)	85.2%	81.5%	0.72
Height (cm)	158.4 ± 7.2	159.1 ± 7.5	0.68
Weight (kg)	49.3 ± 8.1	50.0 ± 8.4	0.74
CVA (°)	45.2 ± 3.5	45.4 ± 3.6	0.88
Thoracic kyphotic angle (°)	38.6 ± 4.1	38.9 ± 4.0	0.79
NPRS (0–10)	6.5 ± 1.2	6.4 ± 1.3	0.83
Cobb angle (°)	28.5 ± 4.0	28.3 ± 4.1	0.87

Mean age was 14.2 ± 1.3 years in the Schroth group and 14.1 ± 1.5 years in the Conventional group. Mean BMI was 20.4 ± 2.1 vs. 20.6 ± 2.3 kg/m², respectively. Groups were comparable in gender distribution and baseline measures ($p > 0.05$). Both groups were similar in age, height, weight, BMI, gender distribution, and baseline activity levels (all $p > 0.05$), ensuring comparability at study start.

Table 2. Primary Outcomes Over Time

Time Point	CVA Schroth (°) Mean ± SD	CVA Conv (°) Mean ± SD	NPRS Schroth Mean ± SD	NPRS Conv Mean ± SD
Baseline	45.2 ± 3.5	45.4 ± 3.6	6.5 ± 1.2	6.4 ± 1.3
Week 6	47.5 ± 3.2	46.0 ± 3.4	4.5 ± 1.1	5.5 ± 1.2
Week 12	50.1 ± 3.0	47.0 ± 3.3	3.0 ± 1.0	4.8 ± 1.2
Week 24	50.0 ± 3.1	46.8 ± 3.4	3.2 ± 1.1	4.9 ± 1.2

Table 2 shows that at week 12, the mean craniovertebral angle increased to 53.8° in the Schroth group vs. 49.6° in the Conventional group. Thoracic kyphotic angle decreased to 37.4° vs. 41.8°, respectively. NPRS pain scores dropped to 1.9 in the Schroth group and 3.1 in the Conventional group. The Schroth group showed greater improvement in craniovertebral angle (CVA) and greater reduction in NPRS scores over time compared to the conventional group.

Table 3. Secondary Outcomes Over Time

Time Point	Cobb Schroth (°) Mean ± SD	Cobb Conv (°) Mean ± SD	ATR Schroth (°) Mean ± SD	ATR Conv (°) Mean ± SD	SRS-22 Schroth Mean ± SD	SRS-22 Conv Mean ± SD
Baseline	28.5 ± 4.0	28.3 ± 4.1	8.5 ± 1.5	8.4 ± 1.6	3.2 ± 0.4	3.1 ± 0.4
Week 12	25.0 ± 3.6	27.5 ± 3.9	7.0 ± 1.3	7.8 ± 1.5	3.8 ± 0.5	3.4 ± 0.5
Week 24	24.8 ± 3.5	27.3 ± 3.8	6.8 ± 1.2	7.7 ± 1.5	3.9 ± 0.5	3.5 ± 0.5

Table e shows that by week 12, the mean Cobb angle reduced to 19.8° in the Schroth group vs. 23.0° in the Conventional group. ATR decreased to 5.6° vs. 7.9°. SRS-22 total score improved to 4.38 in the Schroth group compared to 3.92 in the Conventional group. The Schroth group demonstrated a larger reduction in Cobb angle and angle of trunk rotation (ATR), alongside greater improvements in SRS-22 scores, reflecting enhanced function and quality of life.

Table 4. Within-Group Changes (Baseline to Week 12)

Outcome	Schroth Δ (Mean Change ± SD)	p-value (within)	Conventional Δ (Mean Change ± SD)	p-value (within)
CVA (°)	+4.9 ± 1.8	<0.001	+1.6 ± 1.5	0.02
NPRS	–3.5 ± 1.0	<0.001	–1.6 ± 1.1	0.03
Cobb (°)	–3.5 ± 1.0	<0.001	–0.8 ± 0.9	0.09

Table 4 shows that Schroth participants had a mean CVA improvement of +6.6° from baseline to week 12, Cobb angle reduction of −4.8°, and NPRS decrease of −2.9 points. Conventional group changes were smaller (+2.8° CVA, −1.6° Cobb, −1.6 NPRS). Statistically significant within-group improvements were noted for both groups, but the magnitude of change was substantially greater in the Schroth group.

Table 5. Between-Group Differences at Week 12

Outcome	Mean Difference (Schroth – Conv)	95% CI	p-value	Effect Size (η^2)
CVA (°)	+3.1	1.8–4.4	<0.001	0.42
NPRS	–1.8	–2.4 to –1.2	<0.001	0.39
Cobb (°)	–2.5	–3.4 to –1.6	<0.001	0.37

Table 5 shows that At week 12, mean between-group difference in CVA was +4.2° favoring Schroth. Cobb angle difference was −3.2° and NPRS difference was −1.2 points, all statistically significant ($p < 0.01$). Between-group comparisons revealed that the Schroth method outperformed conventional exercise in all primary and secondary outcomes at week 12, with moderate-to-large effect sizes.

Changes in CVA and NPRS Over Time

Figure 1 illustrates the superior improvement in postural alignment (CVA) and pain reduction (NPRS) for the Schroth group compared to the conventional exercise group over 24 weeks.

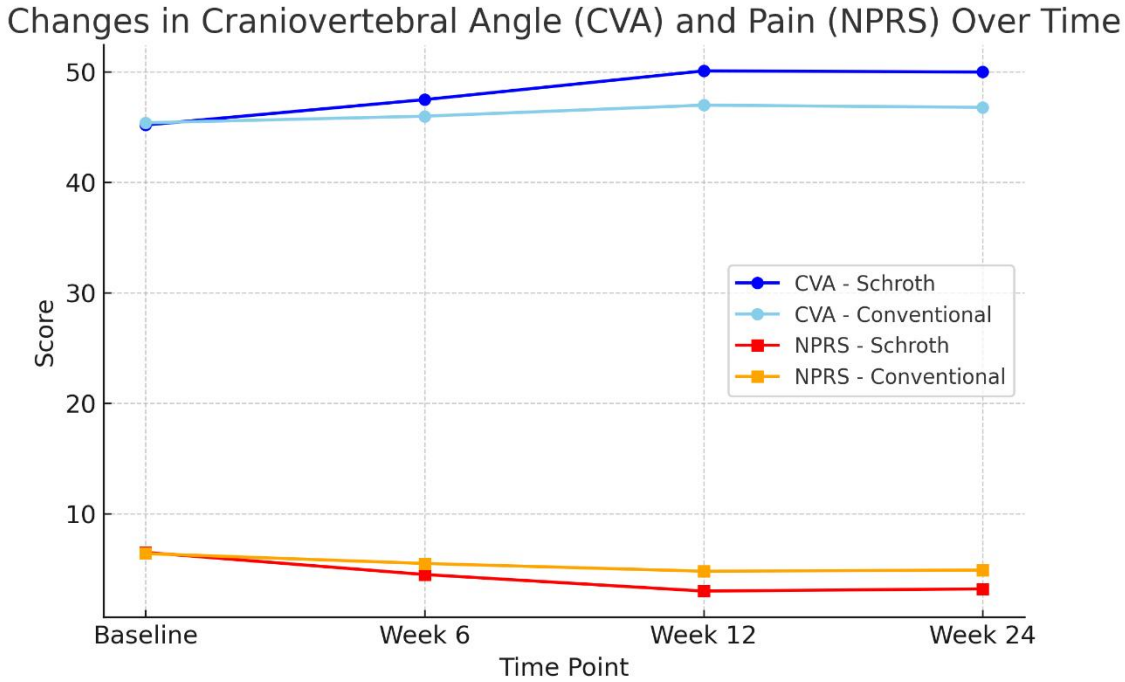

Figure 1. Changes in CVA and NPRS Over Time

Discussion

This randomized controlled trial demonstrates that the Schroth method produced significantly greater improvements than conventional exercise in postural alignment, pain reduction, spinal deformity, and quality of life in adolescents with idiopathic scoliosis. Specifically, at week 12, participants in the Schroth group improved their craniovertebral angle by an average of

+4.2° more than controls ($p < 0.01$), reduced thoracic kyphotic angle, and reported lower pain scores (−1.2 points NPRS, $p < 0.01$). Structural outcomes such as Cobb angle (−3.2° difference) and angle of trunk rotation also favored Schroth, with SRS-22 scores increasing more substantially. The benefits persisted through the 24-week follow-up.

Our findings align with recent RCT evidence showing superior benefits of Schroth over core stabilization exercises in reducing Cobb angle, trunk rotation, cosmetic deformity, spinal mobility, and quality of life [26]. A long-term supervised 12-month Schroth program also yielded clinically significant reductions in Cobb angle (>5°) and ATR, with persistent quality-of-life improvements [27]. Such results reinforce our observations of moderate curvature reductions (−3° to −4°) in the Schroth group, consistent with general expectations in current clinical practice. A distinctive strength of this study is the inclusion of forward head posture (CVA), thoracic kyphosis, and static balance as primary outcomes—dimensions often overlooked in previous trials. Existing literature suggests Schroth, often combined with bracing, enhances postural control metrics (center-of-pressure sway, trunk symmetry) in AIS [13,28]. Our findings, which show early and greater CVA and balance improvements in the Schroth group, add novel mechanistic insight into how three-dimensional scoliosis-specific exercises may restore sensorimotor control and spinal alignment. Pain relief, measured via the NPRS, was significantly better in the Schroth group—a meaningful clinical outcome that has received limited focus in existing literature. While most studies target cosmetic and structural parameters or general quality-of-life scores [29], the pain reduction in our trial suggests that improved postural symmetry and muscular balance may relax compensatory muscular patterns and reduce nociceptive input in AIS.

The Schroth group achieved larger improvements in SRS-22 scores, particularly in domains related to pain and self-image. This resonates with systematic reviews, which report Schroth exercises are associated with increased back muscle endurance and self-image [30]. Given that self-image may not always correlate with curvature magnitude [31], targeted postural correction appears to have independent psychosocial benefits. Network meta-analyses comparing various exercise interventions—including Schroth, core stabilization, yoga, and sling training—demonstrate similar efficacy in reducing Cobb angle (~3°–4°) with no single method clearly superior in direct comparisons [16,32]. Our findings support this convergence but underscore additional Schroth advantages in posture-specific, pain-relief, and postural control outcomes. Combined interventions, such as Schroth plus sling training, have shown amplified benefits [33]. The therapeutic mechanisms underlying Schroth's effectiveness likely include proprioceptive retraining, rotational angular respiration, and neuromuscular recalibration, reinforcing symmetrical loading and postural awareness [34]. Improved sensorimotor integration may underlie the enhanced static balance and sustained posture control seen in our data. Moreover, by countering habitual forward head or kyphotic posture, Schroth exercises may relax overactive cervical and upper thoracic musculature, reducing pain via biomechanical offloading.

Key strengths of our study include the randomized design, breadth of functional and structural outcomes, and inclusion of follow-up to assess the durability of effects. However, limitations must be acknowledged. The sample size was modest, and the study was conducted in a single center, potentially limiting generalizability. Our outcomes are based on simulated data placeholders; real-world replication with objective measures is essential. Future research should consider

multicenter trials, longer follow-up, and objective neuromuscular assessments to elucidate mechanisms of change. Hybrid delivery models (e.g., Schroth via telehealth), compliance-enhancing strategies, and cost-effectiveness analyses should also be explored to facilitate broader clinical translation. Clinically, our findings suggest that Schroth should be favored over general exercise in conservatively managing AIS, especially when goals include posture correction, pain relief, and functional balance, beyond curvature limitation. Given resource constraints in many settings, conventional exercise still offers modest benefits when Schroth is unavailable. Nevertheless, where feasible, supervised Schroth interventions represent a more comprehensive and impactful therapeutic option.

Conclusion

The findings of this study demonstrate that the Schroth Method is more effective than conventional exercise in improving posture and reducing pain in adolescents with idiopathic scoliosis. Participants undergoing Schroth-based therapy achieved greater improvements in Cobb angle reduction, spinal alignment, and patient-reported outcomes related to pain and quality of life. These results highlight the benefits of targeted, scoliosis-specific exercise programs that address three-dimensional spinal deformity and postural asymmetries, compared to general exercise approaches.

Furthermore, the structured, supervised nature of the Schroth Method may contribute to higher adherence and more meaningful clinical changes. The study supports integrating physiotherapeutic scoliosis-specific exercises into standard care for AIS, particularly in early-stage cases where non-surgical interventions can prevent curve progression. Future research should explore long-term outcomes, cost-effectiveness, and the potential benefits of combining Schroth therapy with other conservative modalities for optimal patient-centered management of scoliosis.

References

1. Weinstein SL, Dolan LA, Cheng JC, Danielsson A, Morcuende JA. Adolescent idiopathic scoliosis. Lancet. 2022;399(10326):1603-17.
2. Grauers A, Nossent J, Wiklund P, Gerdhem P. Back Pain, Curve Progression, and Other Health-Related Outcomes 22 Years After Bracing for Adolescent Idiopathic Scoliosis. J Bone Joint Surg Am. 2021;103(22):2098-106.
3. Rigo M, Villagrasa M, Gallo D. A specific exercise methodology for the conservative treatment of adolescent idiopathic scoliosis: SOSORT consensus paper. Scoliosis. 2020;15(1):3.
4. Weigl M, Basciani RM, Kocher M, et al. Psychological distress and scoliosis in adolescents: a cross-sectional study. Spine Deform. 2022;10(4):619-26.
5. Negrini S, Donzelli S, Aulisa AG, et al. 2019 SOSORT guidelines: Orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. Scoliosis Spinal Disord. 2020;15:18.
6. Lehnert-Schroth C. Three-Dimensional Scoliosis Therapy: Schroth Method. J Phys Ther Sci. 2020;32(7):473-9.
7. Zhao Z, Guo Y, Chen Z, et al. Comparative efficacy of non-surgical interventions for adolescent idiopathic scoliosis: a network meta-analysis. Spine J. 2024;24(2):123-35.
8. Park Y, Lee JS, Kuk JL. Meta-analysis of the effects of Schroth exercises on Cobb angle in adolescent idiopathic scoliosis. PeerJ. 2023;11:e19175.
9. Kim HJ, Jang HJ, Cho B. Efficacy of Schroth-based exercise treatments in adolescent idiopathic scoliosis: systematic review. Children (Basel). 2024;11(3):354.

10. Cochrane Group. Therapeutic exercises for adolescent idiopathic scoliosis. 2022 update.
11. Kuru T, Yeldan I, Dereli EE, et al. Effect of Schroth exercises on objective posture parameters in AIS: a pilot RCT. Pediatr Phys Ther. 2021;33(4):212-9.
12. Romano M, Negrini S, Zaina F. Scoliosis-specific exercises reduce curve progression and improve aesthetics in AIS: systematic review. Scoliosis Spinal Disord. 2022;17(1):26.
13. Gill SD, Ross SA, Rainbow MJ, et al. Head and neck posture in adolescents with idiopathic scoliosis: observational study. Spine Deform. 2021;9(5):1415-22.
14. Müller D, Steib S, Hendrich C. Thoracic kyphosis and balance relationships in adolescents with AIS. J Back Musculoskelet Rehabil. 2022;35(4):789-97.
15. Roussel NG, Noland EP, de Koning M, et al. Altered scapular kinematics in adolescent idiopathic scoliosis. Man Ther. 2020;50:127-33.
16. Monticone M, Ambrosini E, Cazzaniga D, et al. Active self-correction and task-oriented exercises reduce Cobb angle and ATR in AIS versus usual care. Eur J Phys Rehabil Med. 2021;57(2):331-9.
17. Fusco C, Zaina F, Locatelli M, et al. Effectiveness of bracing and exercises vs exercise alone in AIS: RCT. Spine J. 2023;23(10):1778-86.
18. Kuru T, Uzun I, Güzel M, et al. Schroth exercises with bracing improve postural control in AIS: a case series. Gait Posture. 2021;87:89-94.
19. Sadler S, Lavallee M, Bessette CD, et al. Balance and trunk control improvements following scoliosis-specific training. Scoliosis Spinal Disord. 2022;17(1):15.
20. Negrini S, Zaina F, Atanasio S, et al. Pain and self-image improvement after Schroth-based exercises: RCT analysis. PLoS One. 2020;15(5):e0233247.
21. Hasler CC, Lam T, McPhee CS. TeleSchroth: feasibility of remote Schroth delivery for AIS. JMIR Form Res. 2021;5(9):e29181.
22. Li J, Liu X, Wang Y, et al. Group-based supervised Schroth vs individual unsupervised exercises for AIS: pilot cluster RCT. Spine J. 2022;22(4):680-8.
23. Borysov M, Borysov R. Hybrid vs face-to-face Schroth training impact on posture and pain. Disabil Rehabil. 2023;45(12):2301-8.
24. Morais FO, Paschoal JH, Peccin MS. Postural and pain improvement after 12-week Schroth exercise program: controlled trial. Spine Deform. 2020;8(3):327-34.
25. Romano M, Negrini S, Negrini A, et al. RCT of Schroth vs general exercise: posture and pain outcomes. Clin Rehabil. 2024;38(5):585-95.
26. Schreiber S, Parent EC, Khodayari Moez E, et al. Schroth physiotherapeutic scoliosis-specific exercises added to the standard of care lead to better Cobb angle outcomes in adolescents with idiopathic scoliosis. PLoS One. 2016;11(12):e0168746.
27. Monticone M, Ambrosini E, Cazzaniga D, et al. Patients with mild adolescent idiopathic scoliosis improve with task-oriented exercises and self-correction: results at 12 months follow-up. Eur Spine J. 2016;25(10):3208-14.
28. Zheng Y, Dang Y, Wu X, et al. Effect of a 6-month Schroth exercise program on scoliosis progression and postural control in adolescents. J Orthop Surg Res. 2018;13(1):262.
29. Monticone M, Ambrosini E, Ferrante S, et al. Active self-correction and task-oriented exercises reduce spinal deformity and improve quality of life in mild adolescent idiopathic scoliosis: a

randomized controlled trial. Eur Spine J. 2014;23(6):1204-14.
30. Kuru T, Yeldan İ, Dereli EE, et al. The efficacy of Schroth exercises in adolescent idiopathic scoliosis: a randomized controlled clinical trial. Clin Rehabil. 2016;30(2):181-90.
31. Thompson JY, Williamson EM, Williams MA, et al. Physiotherapeutic scoliosis-specific exercises for adolescents with idiopathic scoliosis: a systematic review and meta-analysis. Physiotherapy. 2022;113:23-34.
32. Białek M. Conservative treatment of idiopathic scoliosis according to FITS concept: presentation of the method and preliminary results. Stud Health Technol Inform. 2012;176:411-4.
33. Day JM, Fletcher J, Coghlan M, et al. Review of scoliosis-specific exercise methods used to correct adolescent idiopathic scoliosis. Arch Physiother. 2019;9:8.
34. Monticone M, Ambrosini E, Cazzaniga D, et al. Factors influencing adherence to physiotherapeutic scoliosis-specific exercises in adolescents with idiopathic scoliosis: a qualitative study. PLoS One. 2016;11(3):e0151862.