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Effect of Matrix Rhythm Therapy and 3D Schroth Exercises on Postural Alignment in Idiopathic Scoliosis: A 4D Analysis Using DIERS Formetric System - A Case Report

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ABSTRACT

Introduction: Scoliosis is a condition characterized by an abnormal spinal curvature that deviates the spine across all three anatomical planes. It leads to structural changes in the vertebrae, trunk, and intervertebral discs. Scoliosis can emerge at any age, but adolescent idiopathic scoliosis (AIS)—which has no identifiable cause—is the most prevalent form.
Objective: To examine the combined effect of Matrix Rhythm Therapy and 3D spinal corrective exercises on 4D postural analysis in idiopathic structural scoliosis.
Methods: An 18-year-old male with a 4-year history of idiopathic scoliosis presented with thoracic levoscoliosis and lumbar dextroscoliosis (Cobb's angle: 35º). Physical findings included uneven shoulders, right scapular winging, prominent left hip, and trunk deviation. He received a total of 20 sessions, each lasting 90 minutes—comprising 25-30 minutes of Matrix Rhythm Therapy followed by 20 minutes of 3D Schroth Method exercises and 30 minutes manual therapy—administered five days a week over a 30-day period. Objective (4D postural analysis) and subjective (Italian Spine-Related Quality of Life (ISYQOL) questionnaire) assessments were conducted on day 0 and day 30.
Results: Significant change was found in lumbar lordosis angle (46º -31º), sagittal imbalance (6º - 2º), pelvic torsion (4º- 2º), vertebral rotation (2ºR -13ºL), apical deviation (49mm – 21mm), lumbar lordosis depth (32mm- 30mm) and in Cobb's angle from 35º to 25º, along with difference in ISYQOL questionnaire from 37% to 39%.
Conclusion: The effectiveness of a structured and integrative rehabilitation approach that combines Matrix Rhythm Therapy with 3D Schroth exercises, monitored via 4D postural analysis, in the managing idiopathic scoliosis.
Keywords: Scoliosis; 3D Schroth Method; Matrix Rhythm Therapy; 4D Postural Analysis.

INTRODUCTION

The Scoliosis Research Society (SRS) defines scoliosis as a spinal lateral curvature measuring more than 10° in the coronal plane. (1) Scoliosis is an abnormal curvature of the spine that displaces the spine in all

three planes of the body away from its natural position, creating morphological changes in the trunk and intervertebral discs, leading to structural changes in the vertebrae that can develop at any stage of life. (2) Idiopathic scoliosis (IS), the most prevalent form, lacks a known cause and, if untreated it can lead to cardiovascular issues, reduced pulmonary function, chronic pain, and psychological distress. (3,4)

This systematic review and meta-analysis by Mingyang Li *et al*. in July 2024 provide valuable insights into the prevalence and predictors of scoliosis among children and adolescents. Analysing data from 32 studies involving over 55 million participants, the study reports a scoliosis prevalence of 3.1%, with higher rates observed in females and individuals with elevated BMI. Key predictors include gender, age, race, environmental factors, and lifestyle habits. The authors emphasize the need for early detection and preventive education, particularly in high-risk groups. The study's robust methodology makes it a significant contribution to scoliosis research and public health planning. (5) Scoliosis presents in various forms, and its classification is primarily based on the underlying cause.

Scoliosis can be categorized etiologically into idiopathic, congenital, and neuromuscular types. Adolescent idiopathic scoliosis (AIS), the most common form, has an unknown cause, which is reflected in the term “idiopathic”. Depending on when it manifests, idiopathic scoliosis may be classified by age brackets: Infantile (ages 0–3 years), Juvenile (ages 3–10 years), Adolescent (ages 10–18 years), and Adult (ages above 18 years). AIS is most commonly identified in childhood or adolescence, particularly during phases of rapid growth. (5) Treatment options include observation, exercises, wearing orthotic braces, and surgery in more severe cases.

Multiple treatment strategies have been suggested for adolescent idiopathic scoliosis, such as exercise, surgery, traction, bracing, casting, biofeedback, and observation, aiming to correct, prevent, or halt the progression of the spinal deformity. (6) Among the conservative approaches, exercise therapy stands out as a preferred method due to its effectiveness in managing and improving spinal alignment. The Schroth method capitalizes on auto-correction and principles of motor learning and control, and is highly individualized. (2) The Schroth method, based on sensorimotor and kinesthetics principles, stands as the most established and extensively researched approach among physiotherapy scoliosis-specific exercises (PSSE).(7) It is a physiotherapeutic technique that utilizes isometric and other targeted exercises to strengthen or lengthen imbalanced muscles. The program focuses on correcting scoliotic posture and enhancing breathing patterns through proprioceptive and exteroceptive stimulation, along with mirror-guided feedback. Individual learn a correction routine using sensorimotor feedback mechanism and corrective breathing patterns called “rotational breathing”. In this breathing pattern, the inspired air is directed to the concave areas of the thorax, and the ribs are mobilised in these regions by selective contraction of the convex area of the trunk. (8) In turn, Matrix Rhythm Therapy is another non-invasive treatment approach designed to relieve muscle tension and provide rapid pain relief. (9)

Matrix Rhythm Therapy (MRT) is an advanced physiotherapy technique based on the principle of vibromassage, targeting musculoskeletal and neuromuscular conditions. It operates on the concept that healthy muscle cells naturally pulse at a frequency of 8–12 Hz; deviations from this range are associated with increased pain, muscle tension, and impaired tissue function due to altered muscle plasticity and elasticity. MRT helps restore these frequencies to their normal range, thereby alleviating pain and promoting optimal muscle function. It restores tissue resonance to normal by oscillating the tissue back to its normal frequency by vibromassage method.

(9) To objectively assess the postural and structural effects of interventions like Matrix Rhythm Therapy, advanced imaging tools such as the DIERS formetric 4D system are employed.

The DIERS formetric 4D system is a non-invasive, radiation-free imaging technology that employs optical raster stereography to assess spinal posture and alignment. By projecting a grid of horizontal light lines onto the back, the system captures 12 high-resolution images over a 6-second period. These images are analysed to construct a detailed three-dimensional model of the back's surface, allowing clinicians to evaluate spinal curvature, vertebral rotation, and pelvic positioning without the need for radiographic exposure. This method facilitates comprehensive posture analysis and is increasingly utilized in clinical settings for monitoring spinal deformities and postural changes over time. (10)

In recent years, exercise therapy has gained increasing recognition among both clinicians and patients. Among the various physiotherapeutic scoliosis-specific exercise (PSSE) approaches, Schroth three-dimensional corrective training has emerged as one of the most widely adopted and clinically well-received methods. (11)

This study aims to systematically assess the effectiveness of Schroth 3D exercises and Matrix Rhythm Therapy (MRT) in comparison to conventional treatments for adolescents diagnosed with idiopathic scoliosis. While both Schroth exercises and MRT have individually demonstrated positive outcomes in managing scoliosis-related impairments, there is a lack of research evaluating their combined effect. This study seeks to address this gap by exploring the potential synergistic benefits of integrating these two therapeutic approaches.

Additionally, there is a notable absence of research investigating the potential long-term benefits of Matrix Rhythm Therapy as a therapeutic intervention in this population. (9) Therefore, the objective of this study is to provide robust, evidence-based support for the integration of both Schroth 3D exercises and Matrix Rhythm Therapy in the management of adolescent idiopathic scoliosis.

Methodology Case Description- History

An 18-year-old male with a 4-year history of idiopathic scoliosis was initially identified when his mother observed visible asymmetries in his shoulders and pelvis during his high school years. Although he did not experience any significant symptoms at the time, his first diagnostic X-ray revealed a structural spinal deformity, confirming the presence of thoracic levoscoliosis and lumbar dextroscoliosis. The imaging findings showed a right thoracic curve measuring 35° according to Cobb's method, leading to a formal diagnosis of idiopathic scoliosis and the initiation of further clinical evaluation and intervention. He reported the onset of intermittent muscular pain about a year ago, with varying intensity and duration. Despite maintaining independence in functional mobility, including activities of daily living (ADLs), he noted that prolonged physical activity often led to increased pain and episodes of shortness of breath. Additionally, he experienced occasional difficulty climbing stairs, which he attributed to weakness in his left hip. He also mentioned having headaches and disrupted sleep patterns, both of which he associated with the ongoing pain. In the meantime, he continued swimming, his preferred sport, as part of his regular physical activity. Over the past year, the individual underwent various physical therapy interventions, which included the use of heat and cold therapy, manual therapy, and stretching exercises. However, he reported that these approaches did not offer sustained relief from his pain. The individual's goals included eliminating pain, enhancing endurance during prolonged activities, and increasing overall strength. Additionally, he aimed to improve postural alignment, reduce muscle

imbalances, enhance breathing efficiency, and regain confidence in performing daily and recreational tasks independently.

Clinical Impression #1

The individual reported experiencing pain and shortness of breath during prolonged functional activities, along with associated headaches and sleep disturbances. He also noted difficulty ascending stairs, which he attributed to muscle weakness, particularly in the left hip. These symptoms may be linked to postural asymmetries resulting from idiopathic scoliosis. Possible differential diagnoses for his back pain include mechanical conditions such as spondylolysis, spondylolisthesis, compression fractures, facet joint dysfunction, muscular strain or sprain, myofascial trigger points, spinal stenosis, disc degeneration, pelvic misalignment, leg length discrepancy, limited hip range of motion, and abnormal foot mechanics such as excessive pronation. (12,13) Based on the results of the diagnostic imaging the first four could be ruled out; however, the remaining diagnoses could not be ruled out as they can result from scoliosis.

The clinical evaluation primarily involved a detailed postural assessment to evaluate body symmetry, along with Adam's forward bend test, and assessment of range of motion, flexibility, and muscle strength in both the upper and lower limbs as well as the trunk. To assess his quality of life, the Italian Spine-Related Quality of Life Questionnaire was administered on Day 0. Given the limited effectiveness of previous interventions noted in his history, the individual was considered a suitable candidate to initiate Schroth method-based therapy.

Examination

Following informed consent, a comprehensive clinical examination was carried out, beginning with a postural assessment in all anatomical planes. Pain was evaluated using a 10point NPRS, where 0 indicated no pain and 10 represented the worst possible pain. This method is widely recognized for its reliability and validity in clinical settings. (14) The individual reported persistent pain in the right lower back and hip, typically ranging from 5 to 6 out of 10, which worsened with prolonged standing/walking or prolonged activity. Additionally, he experienced a constant dull ache around the right scapular region, rated at 5 out of 10 on the NPRS. On his first visit, he presented with postural abnormalities including: a drooping left shoulder and a pelvic tilt on the same side, accompanied by an S-shaped spinal curvature. Additionally, there was a visible prominence of the inferior angle of the right scapula (Figure 1), elevated and anterior rotated left pelvis, right thoracic convexity with posterior rotated ribs, elevated and winging right scapula, elevated right shoulder, right rounded shoulder, left lumbar convexity, left thoracic concavity with anterior rotated ribs, all of which are consistent with postural deviations commonly seen in individuals with idiopathic scoliosis. (Figure 2,3).

On palpation, there was no rise in local temperature. On the NPRS, he rated his right shoulder and low back pain as 6. On examination, chest expansion was mildly decreased posteriorly. Tenderness was present over the right posterior shoulder. Range-of-motion assessment was done by a goniometer. Muscle strength was assessed manually using the Kendall technique which has shown both good reliability and validity. (15) The individual demonstrated 5/5 strength in bilateral shoulder flexion, abduction, internal and external rotation, elbow flexion and extension and all wrist motions; however, bilateral latissimus dorsi was 4/5 bilaterally. The strength of his lower extremity deficits included bilateral hip abduction (4/5), bilateral gluteus maximus (4/5). The individual's range of motion for his cervical and upper extremities, although tight, was within normal limits. Leg length measurements revealed no discrepancy, with equal lengths recorded on both sides. (16) The forward

bending Adams Test and Formetric 4D readings, which have been shown to have good to adequate reliability as screening tools, were used to assess for the degree of spinal rotation. (17)

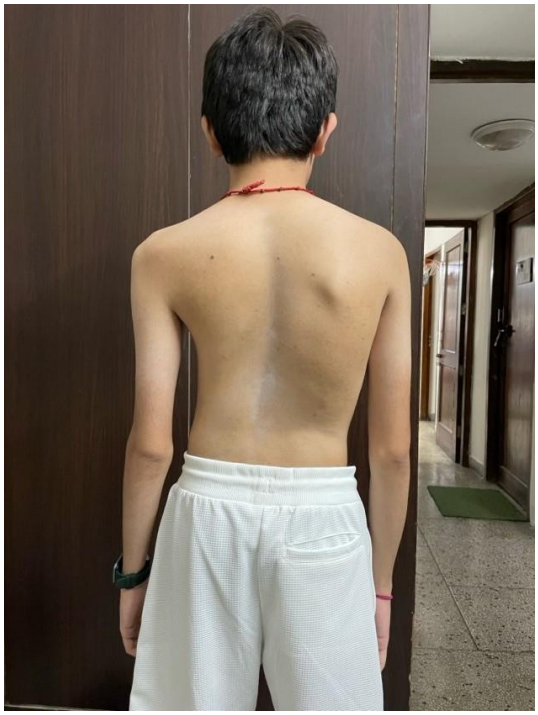


Figure: 1- Visible prominence of the inferior angle of the right scapula

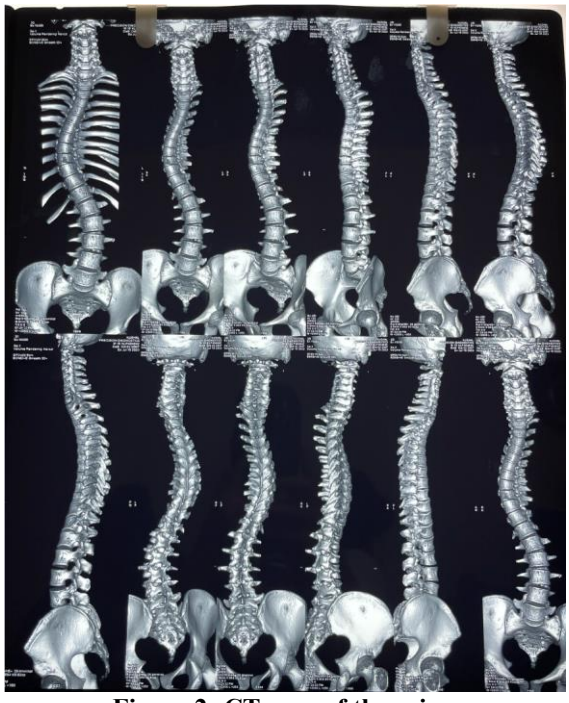


Figure 2- CT scan of the spine

The scoliotic curve is noted with thoracic convex curvature on the right side and lumbar concave curvature on the right side.

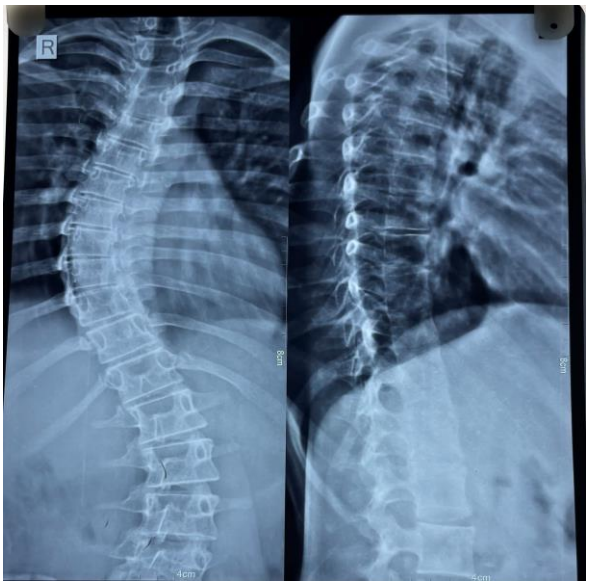


Figure 3: X-ray of the spine (anterior-posterior view and lateral view)

The scoliotic curve is noted with tilting of the spinous process and reduced intervertebral space.

Along with a positive Adam's test, the individual's measurement on the Formetric 4D was 46º lumbar lordosis angle, 6º sagittal imbalance, 4º pelvic torsion, 17º vertebral rotation, 49º apical deviation, 32º lumbar lordosis depth and Cobb's angle from 35º.

Clinical Impression #2

In conjunction with X-ray results, clinical examination findings confirmed the initial impression that postural asymmetries due to scoliosis were the primary cause of the individual's symptoms. Based on the Guide to Physical Therapist Practice, the individual was categorized under musculoskeletal pattern 4B: Impaired posture. The Schroth method was chosen as the intervention to address these postural deviations, as well as associated deficits in flexibility and strength.

Additionally, MRT was incorporated into the treatment protocol to enhance tissue mobility and neuromuscular function. According to Schroth's anatomical block model (Figure 4), the subject was classified as having a 4-curve scoliosis pattern, with a left pelvic shift. His shoulder and lumbar blocks were rotated and deviated to the right, while the thoracic and pelvic blocks were rotated and deviated to the left. A 4-week care plan was outlined, with a reassessment of both subjective and objective measures scheduled after four weeks of intervention.

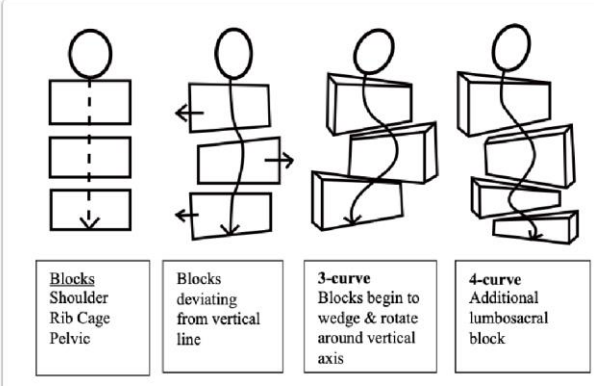


Figure 4: Schroth's Anatomical Blocks.

Intervention

The intervention plan consisted of a combined approach using the Schroth method, MRT and manual therapy, administered five days a week over a period of four weeks (20 sessions). The individual's physical therapy program was divided into two areas of emphasis: manual therapy and instruction in scoliosis exercises as described by the Schroth treatment method.

(8) The Schroth exercises can be divided into three categories:

A. mobilization of the vertebrae, trunk, shoulder girdle and head;
B. shaping through rotational angular breathing to improve spinal alignment; and
C. stretching/strengthening to stabilize spinal de-rotation.

During the initial four weeks of treatment, soft tissue mobilization (STM) was incorporated at the beginning of each session to address muscular tightness and discomfort. Techniques such as myofascial release, trigger point therapy, and passive stretching were applied to areas including the levator scapulae, trapezius, sternocleidomastoid, pectoralis muscles, right quadratus lumborum, right iliotibial band, bilateral piriformis, and the feet. Additional STM, including MRT (figure-5), myofascial release, targeted the diaphragm, right external and left internal obliques, right latissimus dorsi, and right iliopsoas to relieve restrictions and support optimal postural correction and rotational angular breathing (RAB). (Table: 1)

In the initial sessions, considerable focus was placed on educating the individual about scoliosis, the concept of anatomical blocks/wedges, pelvic alignment techniques, rotational angular breathing (RAB), and the correct use of support cushions for passive corrections in hook-lying, seated, and right side-lying positions. Once the individual could independently maintain pelvic alignment, progressively challenging exercises were introduced. Therapist guidance was provided to ensure proper technique and to offer tactile feedback, facilitating optimal postural correction. Throughout the treatment period, various tools such as wall bars, mirrors, resistance bands, cushions, exercise balls, chairs, and tables were used to progressively challenge the individual and promote the integration of postural corrections into daily functional activities (refer to Table 1).

Figure: 5- Matrix Rhythm Therapy

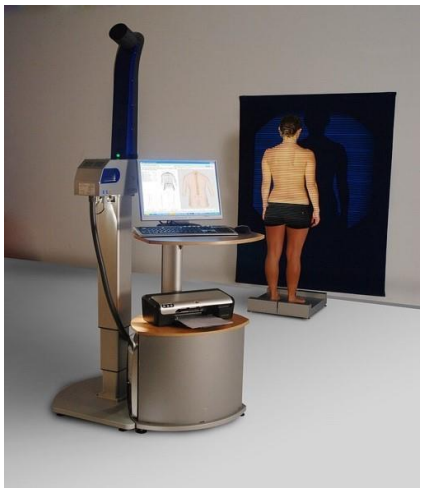


Figure:6- DIERS

Table: 1- Intervention

Week	Patient Education	Intervention	Manual Work
1	• Scoliotic blocks • 5-Pelvic corrections • RAB  Cushion placement **Hooklying** 1. Below left inferior border of scapula 2. Left buttock 3. Right lumbar region **Seated** 1 . Beneath right ischial tuberosity **Right Sidelying** 1. Beneath right lumbar region	• Pelvic Correction in front of Mirror 1. Entire pelvis shifted posterior – Wt in bilateral heels 2. A) Rotation of femur on concave side posterior & external B) Anterior & Caudal movement of hip on convex side 3. Lateral shift of prominent hip on convex side to center 4. A) Posterior shift lumbopelvic block on convex side & anterior shift on concave side B) Frontal pelvic rim is lifted 5. Heel on convex side is pushed into the ground 	Bilateral SCM, Levator Scap, traps, Diaphragm R. ITB R. Pec, Bilateral feet
2	Week 1&2 Stepping practice	 Strengthening of QL with a wedge under his left pelvis • Matrix Therapy (25-30 min for 5 days per week)	As per Weeks 1-2 R. Ext oblique, L. Int oblique, R. QL, Bilateral piriformis
3	Weeks 1&2	 Releasing right lats in front of wall ladder • Matrix Therapy (25-30 min for 5 days per week)	As per weeks 3 R. Lats Iliopsoas
4	Review all activities done in previous week	Review above exercises done in previous week by increasing the reps by 10 of each exercise	

At the 4-week reassessment, the individual reported the pain that was present in the right scapular region on initial evaluation was now eliminated and the right low back and hip symptoms were described as soreness (0/10) versus pain. He had removed the shoe insert without any increase or return of symptoms. His hip abduction and extension were rated 5/5 and he reported ascending and descending stairs were no longer problematic. The Individual reported his shortness of breath while still present had become less frequent (Table 2).

Outcomes

The individual successfully completed 20

physical therapy sessions, which included matrix rhythm therapy, manual therapy, therapeutic exercises designed according to 3D Schroth method, patient education, and a structured home exercise program. Post-intervention he reported complete relief from right scapular, hip, and lower back pain, along with the resolution of sleep disturbances.

He also experienced fewer episodes of shortness of breath and demonstrated an enhanced ability to self-correct his posture, which helped reduce the duration of these episodes when they did occur. Muscle strength in hip abduction and extension remained at 5/5, and he was able to climb stairs without any difficulty. The individual demonstrated consistent adherence to his daily home exercise routine and maintained proper postural corrections. Ultimately, he met both his short- and long-term rehabilitation goals and resumed daily activities without experiencing increased pain or breathing difficulties (see Table 2).

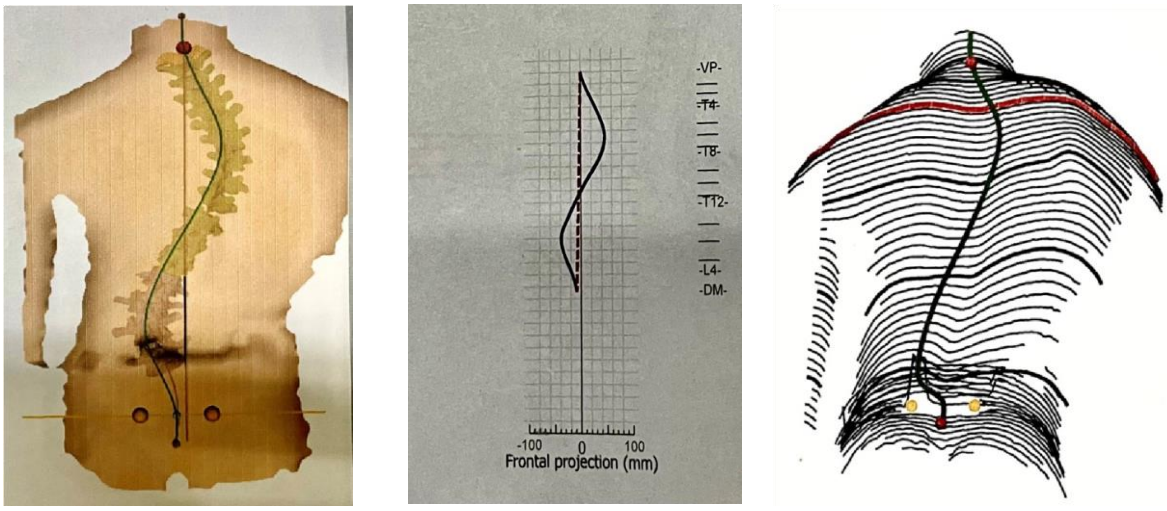
Table 2- Outcomes

	Pre intervention (DAY-0)	**Post intervention (DAY-30)**
PAIN	Right low back: 4-5/10 (constant) Right hip: 4-5/10 (constant) Right scapula: 4/10 (burning)	Right low back: 0/10 Right hip: 0/10 Right scapula: 0/10
STRENGTH	Bilateral latissimus dorsi: 4/5 Bilateral hip abduction: 4/5 Bilateral gluteus maximus: 4/5	Bilateral latissimus dorsi, hip abduction, gluteus maximus: 5/5
FUNCTION	Difficulty with stair negotiation Shortness of breath with prolong activities	No difficulty with stairs Decrease and intermittent Shortness of breath with prolong activities

RESULTS

Table 3- Pre and Post intervention values from 4D Formetric system Pre-intervention images from 4D Formetric system

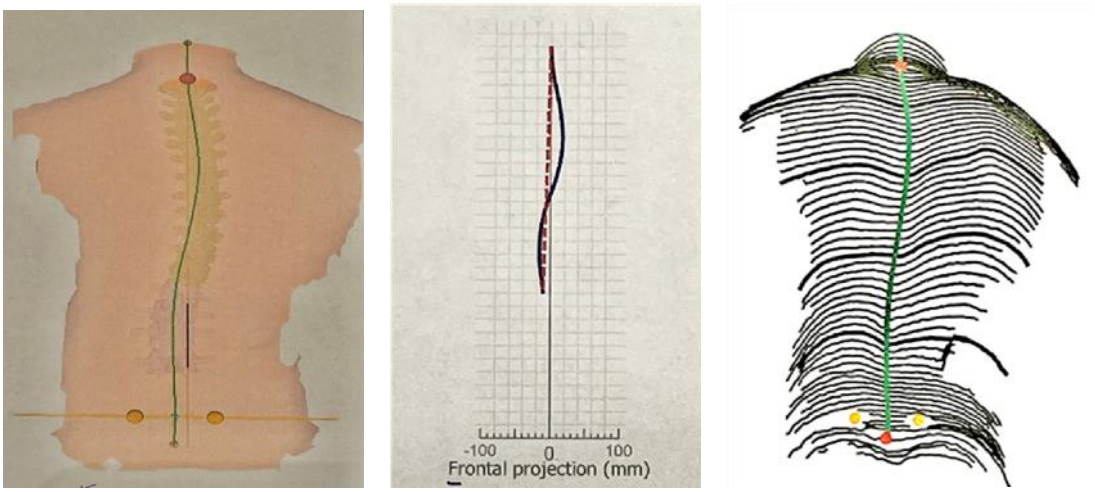
	Pre-intervention	**Post-intervention**
Coronal Imbalance	8 mm R	10 mm R
Sagittal Imbalance	6º P	2º A
Lumbar Lordosis Angle	46º	31º
Vertebral rotation	2º R	13º L
Apical deviation VP- DM (+max)	49 mm R	21 mm R
Apical Deviation	31 mm L	7 mm L
Lumbar Lordosis Depth	32 mm	30 mm
Italian Spine-Related Quality of Life	37%	39%
Cobb's angle	35º	25º



a. **b.** **c.**

Figure:7- a. 3D view; b. frontal projection; c. images showing coronal and sagittal imbalance

Post-intervention images from 4D Formetric system



a. **b.** **c.**

Figure:7- a. 3D view; b. frontal projection; c. images showing coronal and sagittal imbalance

DISCUSSION

The management of scoliosis ranges from simple observation in mild cases to surgical correction for severe or rapidly progressing curves. However, a significant gap exists in the awareness and implementation of conservative interventions, which lie between these two extremes. Despite their proven benefits, approaches such as physiotherapeutic scoliosis specific exercises (PSSE) is still underutilized in India. When scoliosis is non-structural, addressing the curvature in a single anatomical plane can often yield satisfactory results. However, this approach is typically insufficient for individuals with structural scoliosis, where spinal deformities exist across the frontal, sagittal, and transverse planes. In such cases, a multidimensional treatment strategy is essential, as focusing on just one plane may fail to produce effective or lasting improvements.

Multiple articles and studies including systematic reviews, Randomised Controlled Trials (RCT), prospective matched pairs controlled, cohort studies, and case reports have reported positive clinical outcomes with the utilization of exercises specifically for individuals with scoliosis. (2,3,4,7,8,11,14) In an evidence-based review, Hawes (17) highlighted that exercise-based interventions for scoliosis were frequently disregarded or considered to lack effectiveness. Due to such perspectives, exercises were often given a minimal role in scoliosis management, leading many professionals to overlook their possible advantages. However, Hawes pointed out multiple studies indicating that restoring postural balance— regardless of the underlying cause—could alleviate signs and symptoms, even in cases already classified as fixed spinal deformities. The individual in this case report was referred to physiotherapy with complaints of scapular and hip pain, which disrupted his sleep and daily functioning. Following the implementation of postural correction exercises based on the Schroth method and Matrix rhythm therapy, his pain symptoms were resolved.

The traditional intensive inpatient Schroth program—typically lasting 4 to 6 weeks with 5 to 8 hours of therapy per day, 6 days a week, followed by a 30-minute daily home exercise routine—may not be practical in outpatient settings. Recognizing this limitation, Otman *et al.* (18) conducted a study to evaluate the effectiveness of the Schroth method in an outpatient setup. In their study, 50 individuals participated in a six-week program involving four hours of supervised therapy, five days a week. After this clinical phase, the individual continued

with their exercises at home. Assessments conducted at six weeks, six months, and one year included Cobb angle measurements, vital capacity, and muscle strength. The results showed a significant reduction in the mean Cobb angle—from 26.1° at baseline to 23.45° at six weeks, 19.25° at six months, and 17.85° at one year—along with improvements in strength and posture. In this case, the subject underwent five weekly sessions of 60 minutes each, which included reinforcement of corrected postures and progressive exercises tailored to his curve type and Matric Rhythm Therapy. With strong adherence to his home-based curve-specific exercise regimen and consistent implementation of pelvic corrections during daily activities, the individual was able to meet all his short-term and long-term therapeutic goals.

limitations

Despite the positive outcomes observed, this study has some limitations. The intervention was conducted over a relatively short duration of 20 sessions, which may not fully capture the long-term effects or sustainability of improvements. Additionally, the study lacked a control group, making it challenging to attribute changes solely to the combined Schroth and Matrix Rhythm Therapy. Although the 4D Formetric DIERS technique provided a radiation free and non-invasive method to measure spinal curvature and rotation, it may have limitations compared to traditional X-ray imaging in detecting subtle structural changes. Subject's adherence to the home exercise program and postural corrections outside therapy sessions also plays a crucial role and may affect the overall results. Lastly, while the intervention was delivered five days a week for 90 minutes per session, therapist experience with these specialized techniques might have influenced the duration of the treatment. Nevertheless, the combination of Schroth exercises with Matrix Rhythm Therapy optimized soft tissue mobilization, muscular relaxation, and neuromuscular re-education, contributing to improved posture, pain reduction, and functional outcomes. This integrated approach demonstrates promising potential for conservative management of idiopathic scoliosis within a realistic clinical framework.

The integration of Schroth exercises alongside Matrix Rhythm Therapy enhanced soft tissue flexibility, muscle relaxation, and neuromuscular coordination, leading to better postural alignment, decreased pain, and improved functional ability. This combined treatment approach shows encouraging results as a practical and effective conservative option for managing idiopathic scoliosis in everyday clinical practice.

CONCLUSION

Adolescent idiopathic scoliosis is the most prevalent type of scoliosis and can be effectively managed through a structured conservative rehabilitation approach to prevent progression of the deformity. In this case, four weeks of targeted rehabilitation led to notable improvements in posture, muscular strength, and pain levels, thereby reducing the risk of future complications and quality of life. This case report highlights the effectiveness of a well-designed and integrative rehabilitation protocol that combines Matrix Rhythm Therapy with 3D Schroth exercises, monitored through 4D postural analysis, for the management of idiopathic scoliosis.

Declaration by Authors

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