Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 28s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Early Physiotherapy Intervention Following Corrective Surgery for Congenital Scoliosis - A Case Report

Miss. Sairani R. Dalvi[1], Dr. Rama Ramdurgkar*[2], Miss. Prapti R. Desai[3], Dr. Raghavendra Kurdekar[4]

[1]B. PTh, D.Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be University), Kolhapur.

[2*][MPTh Orthopedic Manual therapy, Assistant Professor], Department: Orthopedic manual therapy Physiotherapy, D.Y.Patil College Of Physiotherapy, Kolhapur, D. Y. Patil Education Society (Deemed to be University), Kolhapur

[3]B. PTh, D.Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be University), Kolhapur.

[4]MBBS. JR3 MS, Department of Orthopedics, D Y Patil medical College, Kolhapur, D. Y. Patil Education Society (Deemed to be University), Kolhapur.

Corresponding Author-

Dr. Rama Ramdurgkar.

[MPTh Orthopedic Manual therapy, Assistant Professor], Department: Orthopedic manual therapy Physiotherapy, D.Y.Patil College Of Physiotherapy, Kolhapur, D. Y. Patil Education Society (Deemed to be University), Kolhapur.

Email ID: rkarrama@gmail.com

Cite this paper as: Miss. Sairani R. Dalvi, Dr. Rama Ramdurgkar, Miss. Prapti R. Desai, Dr. Raghavendra Kurdekar, (2025) Early Physiotherapy Intervention Following Corrective Surgery for Congenital Scoliosis - A Case Report, *Journal of Neonatal Surgery*, 14 (28s), 105-115

ABSTRACT

A 13-year-old girl presented with progressive thoracolumbar scoliosis, first noticed at birth. Despite no neurological deficits or gait issues, she experienced intermittent pain and visible postural changes. Examination showed a thoracic hump, muscle spasms, rib crowding, and restricted trunk mobility. She underwent corrective spinal surgery, followed by structured physiotherapy. Early physiotherapy significantly improved recovery, mobility, muscle balance, and overall quality of life

1. INTRODUCTION

Scoliosis is a spinal condition where the spine curves laterally, often with vertebral rotation. A curve exceeding 10 degrees is considered significant [1,2]. Scoliosis types include structural (fixed) and non-structural (flexible). Congenital scoliosis (CS), the most common spinal birth defect, arises due to vertebral malformation during fetal development, often accompanied by heart or kidney anomalies [3-5]A common cause of CS is hemivertebra, which creates uneven vertebral growth, deformities, and can impact cardiopulmonary health. Bracing is typically ineffective; most cases require early surgical correction to halt progression and reduce psychological impact [6].

Surgical options vary based on deformity severity and patient age. Techniques include spinal fusions, osteotomies, and vertebral resections, each with neurological and non-neurological risks [7,8]. Rib anomalies, frequently seen on the concave side, can worsen scoliosis by restricting spinal growth [9,10]. Tethered cord syndrome (TCS), present in 25–37% of CS cases, may require detethering surgery before spinal correction [11].

Surgery is indicated when curves exceed 40°, cause pain, deformity, or psychological distress. Pedicle screw systems are commonly used. Postoperative rehabilitation aims to restore function, prevent complications, and maintain surgical outcomes

2. CASE DESCRIPTION

A 13-year-old girl with right thoracolumbar scoliosis visited D. Y. Patil Hospital. The curve was present since birth and had worsened, although she had no gait or neurological deficits. MRI showed tethering at L2. She first underwent spinal cord detethering on 5th Nov 2024, followed by scoliosis correction on 4th Jan 2025, involving posterior fixation from D1 to L1.

Preoperative physiotherapy educated the patient, preserved muscle and joint function, and introduced breathing techniques using spirometry. As the patient was underweight, nutritional guidance was also provided.

Surgery involved the insertion of pedicle screws and titanium rods, correction under neuromonitoring, and layered closure. Post-surgery, the patient showed back pain and weakness but no comorbidities. Examination revealed scapular asymmetry, rib crowding, and restricted mobility. Pain was rated 7/10 at rest and 9/10 during activity.

Scoliosis assessment:

Patient is a 13year old female, case of congenital scoliosis of thoraco-lumbar spine having convexity to the right side associated with fusion of T5, T6, T7 and T8 vertebral bodies, residing in Kagal, weighing 25kgs and height of 141cm with BMI – 12.4 kg/m^2 (underweight) was admitted in D. Y. Patil Hospital, Kolhapur on 1st January 2025 for a scoliosis correction. Patient was planned for a posterior scoliosis correction and fixation from D1-L1 on 4th January 2025. A post-operative assessment was done on 5th January 2025.

Patient had no significant complaint, pre-operatively. On post-op day 1, patient complained of back pain, generalised weakness and breathlessness. Patient had no underlying co-morbidities. The past surgical history reveals that, patient underwent a cord de-tethering procedure for her tethered cord at two levels, on 7th November 2024.

Age of onset – since birth (congenital)

Pain history:

Onset – gradual for back pain (pre-op); sudden for back pain (post-op)

Precipitating factors – On movements (going into side lying)

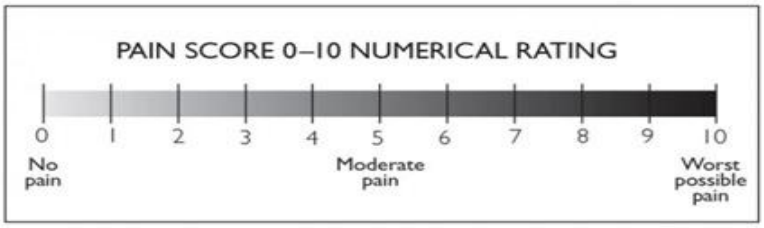
Quality – dull aching.

Relieving factors – analgesics and positioning (supine lying)

Site – Thoracic and upper lumbar region.

Temporal variation – none.

Numerical Pain Rating Scale:



At rest: 7/10 (in supine lying)

On activity: 9/10 (side lying)

Drug history:

Drug name	dose	route	frequency
INJ pantoprazole	20mg	IV	OD

INJ cefuroxime	500mg	IV	TID
INJ PCM	300mg	IV	BD
INJ Tramadol	50mu	IV	BD

On observation

High riding of scapula on the right side.

Direction of growth of curve – right side convexity and left side concavity of thoracic and upper lumbar spine.

Secondary curve – present (lower thoracic and lumbar)

Overcrowding of ribs on the right side.

Central line – present over right side of the neck.

Drain – present on the right side

Bandage – present from thoracic to upper lumbar spine.

On palpation

Tenderness – positive (grade 2- patient winces on palpation)

Site – Thoracic and upper Lumbar spine

Tightness – positive for hamstrings and TA.

On examination

Degree of Cobb's angle – 49 degrees (pre-op)

Tone – not affected.

Range of motion:

Joint	Flexion		Extension		Abduction		Adduction		Internal rotation		External rotation	
	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt
Shoulder	160	180	60	60	0-170	0-180	170-0	180-0				
Elbow	130	140	130-0	140-0								
Wrist	80	80	70	70								
Hip	65	70	20	20	0-40	0-40	40-0	40-0				
Knee	140	140	140-0	140-0								
Ankle	20	20	40	40							r	

Manual Muscle Testing:

Joint	Flexors		Extensors		Abductors		Adductors		Internal rotators		External rotators	
	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt
Shoulder	3/5	3/5	3/5	3/5	2/5	2/5	2/5	2/5	2/5	2/5	2/5	2/5
Elbow	4/5	4/5	4/5	4/5								

Wrist	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5				
Hip	3/5	3/5	3/5	3/5	3/5	3/5	3/5	3/5	3/5	3/5	3/5	3/5
Knee	3/5	3/5	4/5	4/5								
Ankle	3/5	3/5	4/5	4/5								

Limb length – squaring of pelvis 12.5 cm bilaterally,

True limb length:

Right side	Left side
32 inches	32 inches

Apparent limb length:

Right side	Left side
34.2 inches	34.2 inches

Posture –

Anterior view: head is slightly tilted to the right side.

Ears are at unequal level with left ear slightly elevated than the right.

Right shoulder is slightly elevated than the left.

Pelvis appears at a level.

The knees seem to be in neutral alignment.

Toes are slightly pointing inward, suggesting internal tibial torsion or hip

Retroversion.

Lateral view: forward head posture

Rounded shoulders or protracted scapulae

Slight kyphotic posture

Slight anterior pelvic tilt is observed.

Knees appear neutral with no hyperextension or flexion deformity.

Foot alignment is neutral.

Posterior view: head is slightly tilted to the right side.

Right shoulder is elevated.

Winging of scapula is present.

There appears to be lateral shift of the spine towards right side.

Pelvis appears to be at a level.

Knees are neutral in position. Feet appear to be positioned inwardly, suggesting internal tibial torsion.

Anterior view

lateral view

posterior view

Gait –

Cadence – 105 steps/minute

Stride length- 87.2 cm

Step length (right)- 42.7 cm

(left)- 43.4 cm

Step width- 3.9 cm

Toe out angle- 4^0

Sensations – intact

Bowel and Bladder – Regular and independent.

Reflexes – intact (grade 2+ active response)

Co-ordination – maximally intact.

Heel to toe test - positive

Crossed leg sitting – positive

Physiotherapy included ROM assessments, muscle strength testing, and detailed postural and gait analysis. Rehabilitation

was divided into three progressive phases:

Post-operative rehabilitation:

The objectives of Phase 2, that is post-operative active rehabilitation encompassed effective pain management, enhancement of functional lung capacity, restoration of mobility, augmentation of muscular strength, and the prevention of secondary complications. This phase was systematically structured into two distinct weeks.

During the first week, the rehabilitation protocol primarily focused on mobility exercises, supplemented by isometric strengthening of both upper and lower limb musculature. In the second week, the emphasis transitioned towards functional movement training, incorporating activities such as transitioning from a supine to a seated position, progressing from sitting to standing, and ambulation—initially with the assistance of a walker, followed by independent walking. Breathing exercises were incorporated to promote relaxation, prevent post-operative pulmonary complications, improving oxygenation and blood circulation, strengthening of respiratory muscles and to enhance airway clearance. Positioning was given every two hours

Week 1: Day 2 to day 7

During week 1, spanning from Day 2 to Day 7, the rehabilitation regimen comprises a comprehensive suite of exercises conducted twice daily, aimed at promoting functional mobility, muscular strength, and respiratory efficiency. Each exercise is performed for two sets of ten repetitions.

The protocol includes bilateral (B/L) single straight leg raises, ankle pumps, and hip abduction-adduction movements to enhance lower limb circulation and muscle activation. Upper-limb engagement is addressed through B/L shoulder flexion, shoulder abduction-adduction, and bicep curls. Core stability and mobility are further encouraged via log rolling on both sides. Static muscle activation is incorporated for the quadriceps, hamstrings, dorsiflexors, plantarflexors, and abductors, fostering strength without joint strain. Isometric contractions targeting the shoulder flexors, extensors, abductors, adductors are prescribed. Additionally, a dedicated respiratory segment includes diaphragmatic, segmental, and pursed

lip breathing exercises, along with thoracic expansion, all aimed at enhancing pulmonary function and promoting effective ventilation.

Supplementing these physical exercises are spirometry sessions ad systemic repositioning every two hours, specifically alternating side-lying positions, to prevent pressure injuries and support respiratory mechanics. This structured, twice a day routine is essential for optimizing early-stage recovery.

Week 2: Day 8 to day 14

All the exercises from post-operative week 1 were continued in the following week along with additional exercises to improve overall function and to promote independent activities of daily living.During the continuation of the rehabilitation program, a more dynamic set of functional mobility and postural correction exercises is introduced, each to be performed thrice daily to support progressive recovery and improved physical independence.

The regimen begins with foundational transitional movements such as log rolling, side-lying to sitting, and sit-to-stand, reinforcing core strength and movement control. Each is performed for 10 repetitions, with log rolling undertaken in two sets and the others in one set each.

Gait training forms a pivotal component of this phase, emphasizing both mobility and neuromuscular coordination. Activities include heel and toe raises, spot marching, single-leg stance, stepping over a stepper, and walking with or without a walker. Variations such as side-to-side, backward, and obstacle walking, as well as stepping over obstacles, aim to enhance dynamic balance and ambulation. Each gait activity covers 10 meters and is executed in three sets.

Balance and coordination exercises are designed to challenge the base of support (BOS) and sensory integration. These include standing with both wide and narrow BOS, with eyes open and then closed, all performed for three repetitions of 15 seconds each across three sets. This progression helps improve proprioception and stability under varied sensory conditions.

Postural correction is also emphasized through specific corrective drills such as shoulder shrugs, chin tucks, and pectoralis stretches. These are performed in three sets of five repetitions, each held for 15 to 20 seconds, aiming to rectify muscular imbalances and support optimal alignment.

This comprehensive set of exercises is tailored to advance functional independence, stability, and postural integrity, forming a critical part of the rehabilitation continuum.

Third phase : post discharge phase.

The third phase, known as the post-discharge phase, encompassed a structured home-based protocol, systematically divided into three distinct subphases. Each subphase spanned a duration of 15 days, following which the patient was required to attend a follow-up session. These follow-ups were designed to assess progress and refine the exercise regimen for optimal rehabilitation.

Subphase 1: first 15 days of discharge

This phase emphasizes mobility, strength, balance, and posture, with all exercises performed three times daily.

General Mobility

Bilateral upper and lower limb range of motion (ROM) exercises are done in 3 sets of 15 repetitions to restore joint flexibility and fluid movement.

Strengthening Exercises

Upper and lower limb strengthening includes 15 repetitions with a 10-second hold, performed in 3 sets to rebuild muscle strength.

Functional Movements

Log rolling, side-lying to sitting, and sit-to-stand are each done 10 times per side or direction in 3 sets, enhancing basic mobility and independence.

Gait Training

Gait-focused tasks such as heel and toe raises, marching, single-leg stance, stepping over a stepper, walking with or without a walker, backward and obstacle walking are performed 10 times each in 3 sets to improve walking ability and endurance.

Balance and Coordination

Balance drills involve standing with wide/narrow base of support (BOS), with eyes open and closed, each held for 30 seconds, repeated 5 times in 3 sets to enhance stability.

Postural Correction

Includes shoulder shrugs, chin tucks, protraction-retraction, pectoralis and neck stretches, lower limb stretches, and passive trunk rotation. Strength exercises are done for 15 reps; stretches for 5 reps with a 30-second hold, all in 3 sets.

Strength & Core Stability

Wall squats, Superman's pose, and pelvic bridging (with 10-second holds) are each performed in 3 sets of 10 reps to support posture and core strength.

SUBPHASE 2: Next 15 days of discharge.

In this phase, all exercises from Subphase 1 are continued with increased repetitions and sets, alongside the introduction of advanced activities to enhance balance, coordination, strength, and endurance.

Non-Equilibrium Balance Training

Tandem standing is performed in 3 repetitions, each held for 20 seconds, 3 times daily, to improve postural control.

Dynamic Balance & Coordination

Tasks such as tandem walking, single-leg standing, walking with head rotations, 180° turns, and standing on a pillow (both double and single stance) are introduced. Walking exercises are practiced in a 30-meter yard, emphasizing dynamic stability and agility.

Endurance Training

Static cycling (10 minutes) and 1 km walking are performed once per session, twice daily, to build cardiovascular and muscular endurance.

Strength & Core Training Wall squats (15 reps), Superman's pose, pelvic bridging, and bird dog exercises (each 15 reps with a 15-second hold) are executed in 3 sets, 3 times daily, to reinforce muscular strength and trunk stability. This phase intensifies the rehabilitation regimen, fostering greater independence and physical resilience.

Subphase 3: The final 15 days Post-Discharge

This stage includes all exercises from Subphases 1 and 2, with added intensity and new challenges to further enhance recovery.

Advanced Core Strengthening

Superman's pose, Pelvic bridging, Bird dog: 15 repetitions with a 30-second hold, 3 sets, 3 times/day — focusing on core endurance and control.

Balance Training Enhancements

Walking with 360° turns and pillow standing integrated with overhead tasks like throwing and catching a ball.

Performed in a 30-meter yard, once per session, 3 times/day — to promote functional balance and coordination under dynamic conditions.

Endurance Training

Static cycling (15 mins) and Walking (2 km) — done once per session, 2 times/day — to build higher cardiovascular and muscular endurance.

This final subphase prepares the patient for full functional independence through progressive challenges in strength, balance, and stamina.

3. DISSCUSSION

Physiotherapy is crucial after scoliosis surgery, aiding in faster recovery by promoting healing, improving circulation, and reducing swelling. It restores flexibility, strengthens supporting muscles, and maintains spinal alignment. Physiotherapy also improves posture, reduces pain, enhances coordination, and prevents complications. Beyond physical benefits, it offers emotional support and structure during recovery. Overall, physiotherapy ensures holistic rehabilitation and a better quality of life post-surgery.

Early rehabilitation following scoliosis corrective surgery is crucial for ensuring a successful recovery and to minimize the risk of long-term complications. Initiating rehabilitation promptly promotes optimal healing by enhancing circulation, reducing inflammation, and facilitating tissue recovery (Smith et al., 2018). [12]

Early rehabilitation also helps in restoring flexibility and range of motion, particularly in the spine and surrounding muscles, which is essential for preventing stiffness and improving functional movement (Jones & Miller, 2017). By addressing muscle weakness and imbalances early on, rehabilitation helps strengthen the core and back muscles, providing vital support to the newly aligned spine (Taylor et al., 2019). [13]

Moreover, early intervention fosters better posture and spinal alignment, which is key to maintaining the benefits of the surgery (Brown & Davis, 2020). [14] Initiating rehabilitation early can also reduce the likelihood of chronic pain and other complications, such as joint stiffness or mobility issues, by promoting the body's natural healing processes (Anderson & Clark, 2016). [15] Furthermore, early rehabilitation offers psychological benefits, as patients engage in structured activities that boost motivation, reduce anxiety, and enhance overall well-being (Johnson et al., 2021). [16]

Bone formation is vital for successful posterior scoliosis correction (D1–L1), as spinal fusion relies on new bone growth to stabilize alignment. Bone grafts or substitutes support this process, with osteogenesis—bone production by osteoblasts—being key to maintaining correction and preventing scoliosis recurrence [17]. The success of bone healing is influenced by several factors, including the mechanical stability provided by the posterior fixation, the quality of the blood supply to the fused vertebrae, and the patient's overall health and nutritional status (Patel & Warren, 2019). [18] Inadequate bone formation, or delayed union, can result in complications such as pseudarthrosis, where the bone fails to fuse adequately, leading to potential hardware failure or the need for additional interventions (Johnson et al., 2020). [19] Additionally, factors like age, bone mineral density, and underlying conditions like osteoporosis can impact the efficacy of bone formation and fusion success (Khan et al., 2018). [20] Thus, optimizing bone formation through careful surgical technique, postoperative care, and rehabilitation is essential for ensuring the long-term stability of the spine after posterior scoliosis correction from D1-L1.

Early physiotherapy may support bone formation after scoliosis surgery by improving circulation, reducing muscle atrophy, and creating a favourable healing environment. Controlled movement stimulates osteogenesis through mechano-transduction, while improved posture and strength help stabilize fused segments and accelerate healing [21,22].

Bracing after scoliosis surgery stabilizes the spine, reduces deformities, and supports healing. It limits excess motion, eases pain, and maintains posture—especially important for younger patients during spinal fusion [23–26]. Additionally, it offers psychological benefits by instilling confidence and security during rehabilitation (Williams et al., 2016). [27] Thus, bracing is essential for a successful post-surgical outcome.

Breathing exercises are essential after scoliosis surgery to improve lung function, increase oxygen intake, and support respiratory health, which can be affected by spinal changes and surgery (Brown et al., 2018) [28]. They help restore chest expansion and rib mobility, reducing risks like pneumonia (Jones et al., 2017). [29]These exercises also promote relaxation, reduce pain, enhance circulation, and lower anxiety, aiding overall recovery (Smith & Patel, 2019; Kim & Lee, 2016). Incorporating breathing exercises post-surgery is crucial for optimal healing and better quality of life.[30,31]

Early mobility exercises are vital after scoliosis surgery to restore joint flexibility, improve range of motion, and prevent stiffness and muscle loss.[32] They enhance circulation, reduce swelling, and support tissue healing. By maintaining spinal alignment and improving posture, these exercises help sustain surgical correction. Guided early mobility also reduces pain, prevents harmful movement patterns, and boosts patient confidence and emotional well-being. [33,34,35,36]

Stretching exercises are key after scoliosis surgery to improve flexibility, prevent muscle tightness, and maintain proper spinal alignment. They counteract stiffness from spinal fusion, reduce pain, and support posture (Jones & Miller, 2019; Smith

& Patel, 2020). [37,38] Stretching also helps prevent deformities, joint stiffness, and promotes better movement and muscle coordination for long-term spinal health (Taylor et al., 2018; Brown et al., 2017; Williams et al., 2016). Early guided stretching is essential for a smooth, effective recovery. [39,40,41]

Strengthening and core stability exercises are vital after scoliosis surgery to restore muscle function, support spinal alignment, and enhance stability (Brown et al., 2019) [42]. Focusing on core muscles improves posture, trunk control, and prevents harmful compensatory movements. These exercises aid balance, coordination, and reduce injury risk. Typically introduced 6–8 weeks post-surgery, they should be done under supervision to avoid stressing the healing spine or delaying recovery (Jones & Miller, 2017) [43]. Early, guided strengthening boosts recovery and long-term spinal health (Smith & Patel, 2020) [44].

Balance and gait training are crucial after scoliosis surgery to restore movement, improve stability, and enhance mobility. Surgery often leads to balance and walking issues due to weakness and posture changes. Balance training boosts proprioception and coordination (Smith et al., 2018) [45], while gait training corrects stride, asymmetry, and compensatory movements (Jones & Miller, 2019) [46]. Starting within 6 weeks post-op, under professional guidance, ensures safe recovery without straining the surgical site (Taylor et al., 2020) [47], and supports long-term mobility and confidence (Williams et al., 2017) [48].

Endurance training is vital post-scoliosis surgery to boost cardiovascular fitness, muscle endurance, and physical capacity. Activities like walking and cycling improve circulation, reduce fatigue, and support return to daily life (Jones et al., 2017) [49]. It's best introduced 8–12 weeks post-op under professional guidance to avoid stressing the healing spine (Smith & Patel, 2020) [50] and prevent deconditioning (Brown et al., 2019) [51]. Early endurance work enhances recovery, fitness, and mental well-being (Williams et al., 2016) [52]. Overall, early physiotherapy is essential to reduce complications, speed recovery, and restore independence.

4. CONCLUSION

The role of physiotherapy is very important in providing appropriate management after a posterior scoliosis correction with fixation from D1-L1 for congenital scoliosis. Early rehabilitation, taking into consideration the indications and contraindications of the protocol being incorporated, with respect to the condition of the patient, has proven to be effective in accelerating recovery process, reducing the chances of any secondary complications and promoting early functional independence. A customized program designed for every phase, starting from breathing exercises to improve functional lung capacity, mobility exercises to improve joint integrity, to strengthening exercises for improving trunk control and overall strength of the muscles so it can support the healing process and maintain integrity of the surgery performed, simultaneously focusing on functional recovery and independence. A home protocol focusing on balance and coordination training, endurance training was thoroughly designed and made to perform under supervision which helped the patient by gaining maximal functional recovery. Thus, incorporating early physiotherapy after a corrective surgery fastens the recovery process, thereby facilitating functional independence

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