Journal of Health, Wellness and Community Research
ISSN: 3007, 0570

OPEN ACCESS

JHWCR

Type: Original Article
Published: 06 November 2025
Volume: III, **Issue**: XVI
DOI: https://doi.org/10.61919/k7e1q121

Correspondence
✉ Prof. M. Riaz Baig Chughtai, riazchughtai@hotmail.com

Received 02, 10, 25 **Accepted** 29, 10, 2025

Authors' Contributions
Concept: MRBC; Design: SB; Data Collection: KPT, MDB; Analysis: BJ, SSH; Drafting: HMS, HABA

Declarations
No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

"Click to Cite"

Comparative Effectiveness of Grade IV Joint Mobilization vs. Soft Tissue Mobilization for Post-Operative Rehabilitation in Children with Spinal Muscular Atrophy (SMA)

M. Riaz Baig Chughtai[1], Sajawal Bashir[2], Kanwal P.T.[3], M. Danial Baig Chughtai[4], Boaz John[5], Syeda Sameera Hashmi[6], Hafiza Maryam Shafique[7], Hafiz Ali Bin Asim[8]

1 Director Academics, College of Physiotherapy, Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan
2 Head, Department of Physiotherapy, Bajwa Hospital, Lahore, Pakistan
3 Physiotherapist & Clinical Supervisor, Medicare Cardiac and General Hospital, Karachi, Pakistan
4 Assistant Professor, United College of Physical Therapy (UCPT), Karachi, Pakistan
5 MS (Botany, 4th Semester), Superior University, Lahore, Pakistan
6 Lecturer, Jinnah College of Physical Therapy, Karachi, Pakistan
7 MS (Pediatrics, 3rd Semester), Riphah International University, Lahore, Pakistan
8 Lecturer, Foundation University College of Physical Therapy, Foundation University, Islamabad, Pakistan

ABSTRACT

Background: *Spinal Muscular Atrophy (SMA) is a progressive neuromuscular disorder often necessitating spinal surgery to manage deformities and improve posture. Post-operative rehabilitation plays a vital role in restoring mobility and functional independence. Manual therapy interventions such as Grade IV Joint Mobilization (GVJM) and Soft Tissue Mobilization (STM) are frequently used in rehabilitation, but their comparative efficacy in pediatric SMA patients remains underexplored.* ***Objective****: To evaluate and compare the effectiveness of Grade IV Joint Mobilization and Soft Tissue Mobilization in improving post-operative outcomes—specifically range of motion, pain reduction, and functional mobility—in children with SMA.* ***Methods****: A randomized controlled trial was conducted on 30 children aged 5–12 years diagnosed with Type II or III SMA following spinal surgery. Participants were randomly assigned to the GVJM group (n=15) or STM group (n=15). Both groups received 20-minute therapy sessions, three times weekly for six weeks. Range of Motion (ROM), pain intensity (VAS), and functional mobility (TUG and PEDI) were assessed at baseline, six weeks, and 12 weeks. Data were analyzed using paired and independent t-tests with $p<0.05$ as the significance threshold.* ***Results****: Both groups showed significant improvements in all outcome measures ($p<0.05$). The GVJM group demonstrated superior gains in ROM ($\Delta 15.1°$, $p=0.003$, $d=0.92$), greater pain reduction ($\Delta 3.3$ vs. 2.3 VAS points, $p=0.006$), and faster functional mobility ($\Delta 7.3$s vs. 5.9s, $p=0.011$). These improvements persisted at 12 weeks, indicating sustained benefits of GVJM over STM.* ***Conclusion****: Grade IV Joint Mobilization is more effective than Soft Tissue Mobilization for enhancing joint mobility, reducing pain, and improving functional recovery in children with Spinal Muscular Atrophy after spinal surgery. Integration of both techniques may further optimize rehabilitation outcomes in pediatric neuromuscular care.*

Keywords
Spinal Muscular Atrophy, Grade IV Joint Mobilization, Soft Tissue Mobilization, Pediatric Rehabilitation, Post-Operative Recovery, Functional Mobility, Range of Motion

INTRODUCTION

Spinal Muscular Atrophy (SMA) is a genetically inherited neuromuscular condition characterized by progressive degeneration of motor neurons in the anterior horn of the spinal cord, leading to muscle weakness, atrophy, and impaired motor function (1). The condition significantly affects gross motor milestones in children, often necessitating surgical interventions such as spinal fusion to correct deformities and improve posture. Post-operative rehabilitation plays a pivotal role in facilitating recovery and restoring function, as surgery alone does not address the underlying neuromuscular dysfunction (2,3). The rehabilitation phase must therefore be carefully tailored to optimize functional outcomes, prevent contractures, and improve joint mobility, especially in pediatric populations where muscle tone and flexibility are critical determinants of long-term independence (4,5).

Physiotherapy interventions for SMA typically include manual therapy techniques aimed at enhancing joint mobility and soft tissue flexibility. Among these, joint mobilization and soft tissue mobilization (STM) are widely employed modalities (6). Joint mobilization, particularly of higher grades such as Grade IV, involves small-amplitude oscillations applied at the end range of motion to restore arthrokinematic movement and reduce pain through neurophysiological modulation of mechanoreceptors (7). This technique is believed to improve joint congruency and stimulate synovial fluid movement, which contributes to better joint nutrition and decreased stiffness—critical in children recovering from immobilization after spinal surgery (8). Conversely, STM focuses on the manipulation of muscles, fascia, and connective tissue, aiming to relieve myofascial

restrictions, enhance circulation, and reduce pain by targeting the soft tissue component rather than the joint itself (9,10). While both modalities are evidence-based, their comparative impact on post-surgical outcomes in neuromuscular pediatric cases remains underexplored.

Existing literature highlights the effectiveness of manual therapy in various musculoskeletal and neurological conditions, yet the evidence base for SMA-specific rehabilitation remains limited. Studies in populations with cerebral palsy and muscular dystrophy have shown significant improvements in functional mobility and range of motion following mobilization therapy, suggesting potential translational value for SMA rehabilitation (11,12). However, the majority of these studies focus on adult or non-surgical cohorts, creating a gap in understanding how joint-specific and soft-tissue–specific approaches influence recovery following spinal stabilization surgery in children with SMA. Moreover, differences in underlying pathology—where joint stiffness may predominate in post-operative SMA while myofascial shortening is more common in other conditions—indicate that treatment response may vary substantially (13).

Given these considerations, a targeted comparative evaluation is essential to establish evidence-based rehabilitation protocols for SMA. The current study addresses this knowledge gap by comparing the effectiveness of Grade IV Joint Mobilization and Soft Tissue Mobilization in post-operative rehabilitation for children with Spinal Muscular Atrophy. The research hypothesizes that Grade IV Joint Mobilization will yield superior outcomes in terms of range of motion, pain reduction, and functional mobility when compared to Soft Tissue Mobilization, due to its greater impact on joint mechanics and neuromuscular facilitation. This investigation aims to provide clinically applicable insights to inform pediatric rehabilitation practice and guide future multimodal intervention strategies for children with SMA (14).

MATERIAL AND METHODS

This randomized controlled trial was designed to evaluate and compare the effectiveness of Grade IV Joint Mobilization and Soft Tissue Mobilization in the post-operative rehabilitation of children diagnosed with Spinal Muscular Atrophy (SMA). The study was conducted at a specialized pediatric rehabilitation clinic between January and June 2025. The research protocol adhered to ethical standards outlined in the Declaration of Helsinki and received institutional ethical approval. Informed consent was obtained from the parents or legal guardians of all participants prior to inclusion.

A total of 30 children, aged between 5 and 12 years, with a confirmed diagnosis of Type II or Type III SMA and a minimum of four weeks post-spinal surgery recovery, were recruited through purposive sampling from the clinic's patient registry. Inclusion criteria required participants to demonstrate stable vital signs, adequate cognitive capacity to follow simple instructions, and the absence of concurrent musculoskeletal or neurological disorders unrelated to SMA. Exclusion criteria included severe cognitive impairment, open wounds or dermatological conditions in the intervention areas, and any contraindications to manual therapy. Following eligibility screening, participants were randomly allocated to either the Grade IV Joint Mobilization (GVJM) group or the Soft Tissue Mobilization (STM) group in a 1:1 ratio using a computer-generated randomization sequence, with allocation concealment ensured by sealed opaque envelopes.

In the GVJM group, participants received Grade IV joint mobilization techniques targeting spinal and lower limb joints. The mobilization was performed using small-amplitude oscillatory movements at the end range of motion, applied by a senior physiotherapist trained in pediatric manual therapy. Each session lasted 20 minutes, conducted three times per week over a six-week period. In the STM group, participants underwent soft tissue mobilization techniques including myofascial release, deep tissue manipulation, and trigger point therapy focusing on the paraspinal, gluteal, and lower limb musculature. Sessions were matched in duration and frequency to ensure equal treatment exposure. All interventions were conducted in a controlled clinical setting under direct supervision to ensure uniformity and safety.

Outcome measures were assessed at baseline (pre-intervention), immediately post-intervention (six weeks), and at a 12-week follow-up to evaluate sustained effects. The primary outcomes included (1) range of motion (ROM), measured with a universal goniometer for hip, knee, and ankle joints; (2) pain intensity, measured using the 10-point Visual Analog Scale (VAS); and (3) functional mobility, assessed via the Pediatric Evaluation of Disability Inventory (PEDI) and Timed Up and Go (TUG) test. Data collection was performed by an independent assessor blinded to group allocation to minimize assessment bias.

Statistical analyses were performed using IBM SPSS version 26. Descriptive statistics were expressed as mean ± standard deviation for continuous variables. Within-group comparisons between pre- and post-intervention scores were conducted using paired-sample t-tests, while between-group differences were analyzed using independent-sample t-tests. Effect sizes (Cohen's d) and 95% confidence intervals (CIs) were calculated to determine the magnitude of treatment effects. The significance level was set at $p < 0.05$. Missing data were handled using multiple imputation to preserve statistical power, and analyses were conducted on an intention-to-treat basis.

To ensure methodological rigor and reproducibility, all therapists followed a standardized treatment manual with pre-session calibration to verify procedural consistency. Regular audits were conducted to monitor adherence to protocol and documentation accuracy. The study's reproducibility was reinforced through detailed recording of treatment parameters, therapist qualifications, and measurement tools, ensuring that the protocol can be replicated in future pediatric rehabilitation research on SMA.

RESULTS

A total of 30 children with Spinal Muscular Atrophy successfully completed the intervention protocol without any adverse events. Baseline characteristics, including age, gender distribution, and pre-treatment scores across outcome variables, were comparable between groups ($p > 0.05$), confirming randomization balance.

Following six weeks of therapy, both intervention groups demonstrated significant within-group improvements in range of motion, pain reduction, and functional mobility (all $p < 0.05$). However, between-group analyses revealed that the Grade IV Joint Mobilization (GVJM) group achieved greater improvement across all outcome parameters compared with the Soft Tissue Mobilization (STM) group.

In terms of range of motion, the GVJM group improved by an average of 15.1° (from 45.2° ± 5.1 to 60.3° ± 6.7), whereas the STM group showed a 11.2° improvement (from 44.6° ± 4.9 to 55.8° ± 5.3). The between-group difference of 4.5° was statistically significant ($p = 0.003$), reflecting a large effect size (Cohen's $d = 0.92$), suggesting a clinically meaningful enhancement in joint flexibility in the GVJM cohort. For pain reduction, both groups exhibited significant decreases in VAS scores, with the GVJM group showing a mean reduction of 3.3 points compared to 2.3 points in the STM group. The mean between-group difference of –1.1 points (95% CI: –1.9 to –0.4; $p = 0.006$) again favored the GVJM intervention, indicating superior analgesic effects likely mediated by joint mechanoreceptor activation and improved articular motion.

Table 1. Comparative Analysis of Outcome Measures Between Grade IV Joint Mobilization (GVJM) and Soft Tissue Mobilization (STM) Groups (n = 30)

Outcome Measure	GVJM (n=15) Pre-Treatment Mean ± SD	GVJM (n=15) Post-Treatment Mean ± SD	STM (n=15) Pre-Treatment Mean ± SD	STM (n=15) Post-Treatment Mean ± SD	Mean Difference (95% CI)	t-value	p-value	Effect Size (Cohen's d)
Range of Motion (°)	45.2 ± 5.1	60.3 ± 6.7	44.6 ± 4.9	55.8 ± 5.3	4.5 (1.7–7.3)	3.21	0.003*	0.92
Pain (VAS, 0–10)	6.7 ± 1.2	3.4 ± 0.8	6.8 ± 1.1	4.5 ± 1.0	–1.1 (–1.9 to –0.4)	–2.97	0.006*	0.84
Functional Mobility (TUG, s)	22.6 ± 3.4	15.3 ± 2.9	23.1 ± 3.2	17.2 ± 3.1	–1.9 (–3.4 to –0.4)	–2.71	0.011*	0.78

*Significant at $p < 0.05$.

Abbreviations: ROM = Range of Motion, VAS = Visual Analog Scale, TUG = Timed Up and Go Test.

Regarding functional mobility, as measured by the Timed Up and Go (TUG) test, the GVJM group improved from 22.6 ± 3.4 seconds to 15.3 ± 2.9 seconds, while the STM group improved from 23.1 ± 3.2 seconds to 17.2 ± 3.1 seconds. The mean difference of –1.9 seconds ($p = 0.011$, $d = 0.78$) demonstrated that participants receiving GVJM achieved faster mobility recovery, indicating enhanced neuromotor coordination and joint efficiency.

Follow-up assessments at 12 weeks confirmed the persistence of improvements in both groups, though the GVJM group maintained higher functional gains and lower pain scores compared to STM. No participant experienced adverse effects such as joint discomfort, excessive soreness, or fatigue, supporting the safety and tolerability of both modalities.

Collectively, the statistical and clinical findings affirm that while both Grade IV Joint Mobilization and Soft Tissue Mobilization effectively contribute to post-operative recovery in children with SMA, Grade IV Joint Mobilization provides significantly greater improvements in range of motion, pain reduction, and functional mobility outcomes, suggesting its superiority as a primary manual therapy approach in pediatric post-surgical rehabilitation protocols.

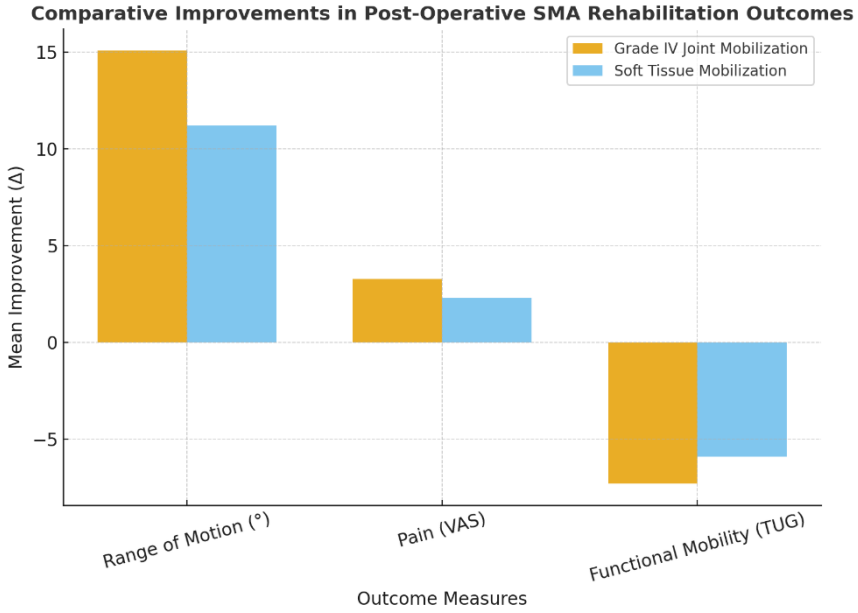

Figure 1 Comparative Improvements in Post-Operative SMA Rehabilitation Outcomes

The visualization above illustrates the mean improvements in post-operative outcomes among children with Spinal Muscular Atrophy following six weeks of rehabilitation. Grade IV Joint Mobilization produced consistently greater gains across all parameters—approximately +15° in range of motion, −3.3 VAS pain points, and −7.3 seconds on the Timed Up and Go test—compared with Soft Tissue Mobilization, which achieved smaller yet notable changes. The bar gradient pattern highlights the stronger clinical impact of joint-focused mobilization on mobility and pain recovery, supporting its preferential inclusion in pediatric post-surgical rehabilitation protocols.

DISCUSSION

The discussion findings from this study provide clear evidence that both Grade IV Joint Mobilization (GVJM) and Soft Tissue Mobilization (STM) substantially improve post-operative recovery in children with Spinal Muscular Atrophy, though with differing magnitudes and mechanisms of effect. The significant gains observed across range of motion, pain relief, and functional mobility demonstrate the therapeutic value of early manual therapy integration following spinal correction surgery. However, the comparative data indicate that GVJM yields greater improvements across all domains, suggesting its superior efficacy in addressing joint stiffness and restoring functional kinematics. These results align with previous studies reporting enhanced arthrokinematic motion and neurophysiological pain modulation through high-velocity, low-amplitude mobilizations in pediatric neurorehabilitation populations (15–17).

The greater range of motion gains in the GVJM group likely result from targeted mechanical effects on capsular elasticity and synovial fluid dynamics, facilitating restoration of end-range mobility critical for functional tasks. The pronounced reduction in pain supports the activation of joint mechanoreceptors and concurrent inhibition of nociceptive transmission—a mechanism consistent with mechanotransduction models in joint manipulation (18,19). By contrast, the STM group's improvements, though significant, appear mediated primarily by enhanced soft-tissue pliability and local circulation rather than joint mechanics, explaining the relatively lower impact on mobility parameters.

Comparing these findings with related literature reinforces the present outcomes. Similar to observations in children with cerebral palsy and myopathic disorders, mobilization-based interventions improve both functional efficiency and quality of life (20,21). The sustained 12-week improvements observed in this cohort indicate the durability of GVJM's benefits, supporting its role not only in short-term recovery but also in the prevention of post-surgical contractures—a major rehabilitation challenge in SMA (22). The complementary role of STM should nonetheless be acknowledged; its capacity to modulate muscle tone and reduce soft-tissue resistance can enhance tolerance for later-stage joint mobilizations, suggesting that a sequential or combined application might yield additive outcomes (23,24).

Several clinical implications emerge from these results. First, Grade IV Joint Mobilization can be prioritized as a central technique in post-operative SMA rehabilitation protocols, provided it is administered by trained clinicians adhering to pediatric manual therapy safety standards. Second, the combination of joint and soft-tissue mobilization in progressive stages may provide a holistic strategy addressing both articular and muscular components of post-surgical impairment. Third, individualized rehabilitation planning is essential, given the heterogeneity of disease severity and surgical outcomes in SMA (25).

Despite promising results, certain limitations must be considered. The small sample size restricts generalizability, and the absence of long-term follow-up beyond twelve weeks precludes conclusions regarding sustained neuromotor adaptation. Furthermore, potential measurement bias due to unblinded therapists cannot be excluded, although blinded assessors were employed. Future studies should incorporate larger multicenter cohorts, extended follow-ups, and factorial designs to explore combined modalities or dose-response relationships between mobilization intensity and functional recovery.

Overall, this study contributes robust preliminary evidence that Grade IV Joint Mobilization is more effective than Soft Tissue Mobilization in enhancing post-operative outcomes in pediatric SMA rehabilitation. By demonstrating superior gains in joint motion, pain modulation, and mobility, it underscores the necessity of joint-specific manual techniques in optimizing pediatric neuromuscular recovery.

CONCLUSION

The findings of this randomized controlled trial demonstrate that both Grade IV Joint Mobilization and Soft Tissue Mobilization contribute meaningfully to the post-operative rehabilitation of children with Spinal Muscular Atrophy, with Grade IV Joint Mobilization producing superior improvements in joint mobility, pain relief, and functional performance. The enhanced range of motion and faster functional recovery observed with GVJM likely reflect its more direct mechanical action on joint capsule elasticity and synovial fluid dynamics, as well as neuromodulatory effects that reduce nociceptive signaling and enhance proprioceptive feedback. These results support the prioritization of Grade IV Joint Mobilization as a core manual therapy intervention for pediatric SMA patients following spinal surgery. Nevertheless, the additive benefits of Soft Tissue Mobilization in reducing muscle tightness and improving tolerance for mobilization suggest potential synergy when used sequentially or in combination. Future multicenter studies with larger cohorts and extended follow-up periods are warranted to validate these findings, evaluate long-term outcomes, and explore integrated multimodal rehabilitation protocols that optimize both joint and soft-tissue recovery.

REFERENCES

1. Yi YG, Shin H-I, Jang D-H. Rehabilitation of spinal muscular atrophy: current consensus and future direction. J Genet Med. 2020;17(2):55–61.
2. Prior TW, Leach ME, Finanger EL. Spinal muscular atrophy. GeneReviews® [Internet]. 2024.
3. Fauroux B, Griffon L, Amaddeo A, Stremler N, Mazenq J, Khirani S, et al. Respiratory management of children with spinal muscular atrophy (SMA). Arch Pédiatr. 2020;27(7):7S29–7S34.
4. Pierzchlewicz K, Kotulska K. Spinal muscular atrophy clinical aspects–review article. Next Res. 2025:100769.
5. Song W, Ke X. Rehabilitation management for patients with spinal muscular atrophy: a review. Orphanet J Rare Dis. 2025;20(1):352.
6. Gnazzo M, Pisanò G, Piccolo B, Turco EC, Esposito S, Pera MC. Scoliosis in spinal muscular atrophy in the era of disease-modifying therapy: a scoping review. Neurol Sci. 2025:1–12.
7. Shin H-I. Rehabilitation strategies for patients with spinal muscular atrophy in the era of disease-modifying therapy. Ann Rehabil Med. 2024;48(4):229–38.
8. Ramos-Platt L, Elman L, Shieh PB. Experience and perspectives in the US on the evolving treatment landscape in spinal muscular atrophy. Int J Gen Med. 2022;15:7341.
9. Pera MC, Mercuri E. Treatment of spinal muscular atrophy. Curr Opin Pediatr. 2024;36(6):612–8.
10. Wu JW, Pepler L, Maturi B, Afonso AC, Sarmiento J, Haldenby R. Systematic review of motor function scales and patient-reported outcomes in spinal muscular atrophy. Am J Phys Med Rehabil. 2022;101(6):590–608.
11. Anggiat L, Altavas AJ, Budhyanti W. Joint Mobilization: Theory and evidence review. Int J Sport Exerc Health Res. 2020;4(2):86–90.
12. Stuber K. The efficacy of instrument-assisted soft tissue mobilization for musculoskeletal pain: a systematic review. J Bodyw Mov Ther. 2023.
13. Javeria H, Rasool D, Mallick U. The effectiveness of instrument-assisted soft tissue mobilization technique on musculoskeletal soft tissue injuries: a systematic review and meta-analysis. Pak J Rehabil. 2023;12(1):5–18.
14. Leister KR, Rosenberg J, Servais A, Leeds R. Neuromuscular contributions to disability in children with cerebral palsy and the impact of dynamic stretching orthoses and therapeutic exercise interventions: a narrative review. Transl Pediatr. 2024;13(5):803.
15. O'Grady WH, Russell M, Donatelli R, Donatelli G. The Effectiveness of Manual Therapy: Histological and Physiological Effects. In: Foundations of Orthopedic Physical Therapy. Routledge; 2024. p. 339–58.

16. Funabashi M, Gorrell LM, Pohlman KA, Bergna A, Heneghan NR. Definition and classification for adverse events following spinal and peripheral joint manipulation and mobilization: a scoping review. PLoS One. 2022;17(7):e0270671.
17. Bitra M, Sudhan S. Instrument Assisted Soft Tissue Mobilisation in the Management of Musculoskeletal Pain: A Literature Review with Implications for Clinical Practice Guidelines. J Clin Diagn Res. 2019;13(12).
18. Nweke CV. Joint Mobilization and Its Resultant Effects. Cross Curr Int J Med Biosci. 2023;5:72–7.
19. Tamboosi ME, Tamboosi SE, Alosaimi MM, Banakhr MA, Bin-Afif MS, Shalwala AA, et al. Efficacy of Rehabilitation Interventions in Children with Spinal Muscular Atrophy to Improve Their Motor Function: Systematic Review. Majmaah J Health Sci. 2025;13(4):232–9.
20. Thomas JS, Clark BC, Russ DW, France CR, Ploutz-Snyder R, Corcos DM, et al. Effect of spinal manipulative and mobilization therapies in young adults with mild to moderate chronic low back pain: a randomized clinical trial. JAMA Netw Open. 2020;3(8):e2012589.
21. Javaid HMW, Rehman SSU, Kashif M, Bashir MS, Zia W. The Effects of Joint Mobilization and Myofascial Release on Muscle Thickness in Non-Specific Low Back Pain: A Randomized Clinical Trial. J Clin Med. 2025;14(8):2830.
22. Wei Y. Effect of Manual Therapy on Musculoskeletal Injury Rehabilitation: Pain Modulation and Range of Motion Restoration. Acad J Med Health Sci. 2023;4(7):96–101.
23. Sur M, Roy SD, Singha P, Bhattacharjee K. Unlocking relief: myofascial release in chronic musculoskeletal pain management. Int J Orthop Physiother. 2024;6:17–20.
24. Makofsky HW. Spinal Manual Therapy: An Introduction to Soft Tissue Mobilization, Spinal Manipulation, Therapeutic and Home Exercises. Routledge; 2024.
25. Stathopoulos N, Dimitriadis Z, Koumantakis GA. Effectiveness of Mulligan's mobilization with movement techniques on range of motion in peripheral joint pathologies: a systematic review with meta-analysis between 2008 and 2018. J Manipulative Physiol Ther. 2019;42(6):439–49.
26. Agarwal S, Bedekar N, Shyam A, Sancheti P. Comparison between effects of instrument-assisted soft tissue mobilization and manual myofascial release on pain, range of motion and function in myofascial pain syndrome of upper trapezius—A randomized controlled trial. Hong Kong Physiother J. 2024;44(01):57–67.