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Original Article

The Effectiveness of Instrument Assisted Soft Tissue Mobilization (IASTM) and Myofascial Release (MFR) in Reducing Delayed Onset Muscle Soreness (DOMS) in the Cervicothoracic Region

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ABSTRACT

Background: Delayed-onset muscle soreness of the cervicothoracic region may cause pain, stiffness, functional limitation, and reduced cervical range of motion after unfamiliar or strenuous upper-body activity. Instrument-assisted soft tissue mobilization and myofascial release are commonly used manual therapy techniques, but their comparative short-term effects in cervicothoracic DOMS remain insufficiently defined. **Objective:** To compare the effects of IASTM and MFR on pain intensity, neck-related disability, and cervical range of motion in adults with cervicothoracic DOMS. **Methods:** This assessor-blinded randomized controlled trial included 58 participants aged 25–35 years with clinically confirmed cervicothoracic DOMS of 24–72 hours' duration. Ethical approval was obtained from the Ethics Committee of Green International University under approval number NCT07609498. Participants were randomized equally to IASTM (n = 29) or MFR (n = 29). Each group received three treatment sessions. Pain was assessed using the Visual Analog Scale, disability using the Neck Disability Index, and cervical ROM using goniometry. Outcomes were measured at baseline and after each session. Data were analyzed using between-group comparisons and 2 × 4 mixed-design repeated-measures ANOVA. **Results:** Baseline characteristics and outcome scores were comparable between groups. Both interventions produced significant improvements over time; however, IASTM showed greater final improvement than MFR in VAS (1.45 ± 0.31 vs 2.72 ± 0.35), NDI (6.10 ± 1.02 vs 9.78 ± 1.41), flexion (53.65 ± 1.71° vs 49.02 ± 2.20°), extension (59.43 ± 2.44° vs 54.42 ± 2.18°), and bilateral lateral flexion and rotation. Time × group interactions were significant for all outcomes. **Conclusion:** Both IASTM and MFR improved cervicothoracic DOMS over three sessions, but IASTM produced greater short-term reductions in pain and disability and larger improvements in cervical ROM. **Keywords:** Instrument-Assisted Soft Tissue Mobilization; Myofascial Release; Delayed-Onset Muscle Soreness; Neck Disability Index; Cervical Range of Motion; Randomized Controlled Trial.

INTRODUCTION

Delayed-onset muscle soreness is a transient exercise-induced musculoskeletal condition that typically emerges several hours after unfamiliar or strenuous activity, particularly after eccentric muscle loading, and is characterized by pain, tenderness, stiffness, temporary weakness, and restriction of movement (1). Although DOMS is often self-limiting and may represent part of the adaptive response to repeated

loading, its clinical relevance increases when symptoms affect regions essential for posture, head-neck control, shoulder-girdle coordination, and functional mobility. The cervicothoracic region has a central role in maintaining cervical alignment, upper thoracic extension, scapular positioning, and coordinated upper-quarter movement; therefore, soreness and fascial restriction in this region may interfere with daily activities, exercise participation, work-related postures, and perceived functional ability (2,3).

The pathophysiology of DOMS is multifactorial and is commonly attributed to mechanical disruption of sarcomeres and surrounding connective tissue after eccentric loading, followed by inflammatory mediator release, nociceptor sensitization, edema, and increased intramuscular pressure (1,3). In the cervicothoracic region, muscles such as the upper trapezius, levator scapulae, rhomboids, and cervical-thoracic paraspinals are frequently exposed to repetitive loading, sustained postural demand, and sudden exercise progression, making them vulnerable to post-exercise soreness and movement limitation. Pain arising from these tissues may reduce cervical flexion, extension, lateral flexion, and rotation, while associated stiffness and fear of movement may contribute to short-term disability as reflected by patient-reported functional scales (4).

Manual soft-tissue interventions are commonly used in rehabilitation practice to reduce pain, improve tissue mobility, and restore range of motion in musculoskeletal conditions involving fascial tightness and soft-tissue sensitivity. Instrument-assisted soft tissue mobilization is a technique in which specially designed tools are used to apply controlled mechanical strokes to soft tissue with the aim of reducing adhesions, improving tissue extensibility, stimulating local circulation, and modulating pain perception (5,6). Myofascial release is a hands-on technique that applies sustained pressure and stretch to restricted fascial tissues to reduce perceived tightness, improve mobility, and decrease pain-related functional limitation (7). Both techniques are used clinically in neck and upper-quarter disorders, and emerging evidence suggests that each may improve pain, disability, and range of motion in musculoskeletal conditions involving the cervical region (4,7,8).

Previous studies have reported beneficial effects of IASTM on pain, function, and range of motion in musculoskeletal populations, including patients with neck pain and soft-tissue dysfunction (5,6,8). Evidence also supports the therapeutic role of MFR in chronic neck pain and related myofascial conditions, although treatment effects appear to vary according to population, technique, dose, and outcome domain (4,7). Comparative studies in chronic neck pain and upper trapezius myofascial pain suggest that both IASTM and MFR can produce clinically relevant improvement, but findings are not fully consistent regarding superiority of one method over the other (9,10). Importantly, most available evidence concerns chronic neck pain, mechanical neck pain, myofascial trigger points, or general musculoskeletal disorders rather than acute cervicothoracic DOMS. This distinction is clinically important because DOMS has a different temporal profile, tissue irritability pattern, and spontaneous recovery trajectory compared with chronic neck pain, and short-term treatment response may therefore differ.

The current evidence gap is not the complete absence of IASTM and MFR comparison studies, but the limited comparative evidence specifically addressing acute cervicothoracic DOMS using pain intensity, neck disability, and multidirectional cervical range of motion as concurrent outcomes. Establishing whether IASTM provides superior short-term recovery compared with MFR in this population may help clinicians select a more effective manual therapy approach for patients or active adults presenting with post-exercise cervicothoracic soreness. Using a PICO framework, the population of interest was adults aged 25–35 years with clinically confirmed cervicothoracic DOMS, the intervention was IASTM, the comparator was MFR, and the outcomes were pain intensity measured by the Visual Analog Scale, functional disability measured by the Neck Disability Index, and cervical range of motion measured across flexion, extension, bilateral lateral flexion, and bilateral rotation. Therefore, this randomized controlled trial aimed to compare the short-term effects of IASTM and MFR on pain, disability, and cervical range of motion in adults with cervicothoracic DOMS. The study hypothesis was that IASTM

would produce greater reduction in pain and disability and greater improvement in cervical range of motion than MFR after three treatment sessions.

MATERIALS AND METHODS

This study was conducted as an assessor-blinded, two-arm randomized controlled trial comparing the short-term effects of instrument-assisted soft tissue mobilization and myofascial release in adults with cervicothoracic delayed-onset muscle soreness. The trial was carried out in the Physical Therapy Department of Johar Child Poly Clinic, Johar Town, Lahore, Pakistan, over a 9-month period following approval of the study synopsis. The design was selected to allow direct comparison of two active manual therapy interventions under standardized clinical conditions, with repeated outcome assessment across treatment sessions to determine both within-group recovery and between-group differences in response.

Participants were recruited using non-probability purposive sampling and were subsequently randomly allocated to one of the two treatment arms after eligibility confirmation and baseline assessment. Adults of either sex aged 25–35 years were eligible if they had clinically confirmed cervicothoracic DOMS of 24–72 hours' duration, normal neuromuscular screening without signs of radiculopathy, and radiographic clearance showing no structural abnormality. DOMS was identified clinically on the basis of delayed onset of cervicothoracic muscle soreness after recent unfamiliar or strenuous upper-body activity, localized tenderness or stiffness in the cervicothoracic soft tissues, and movement-related discomfort without features suggestive of acute traumatic or neurological pathology. Participants were excluded if they had fever, unexplained weight loss, night pain, history of spinal trauma or surgery, inflammatory or systemic musculoskeletal disease such as rheumatoid arthritis or ankylosing spondylitis, bleeding tendency, local skin lesion, contraindication to manual soft-tissue therapy, abnormal radiographic findings such as fracture, tumor, or severe degeneration, or any neurological or muscular condition that could be aggravated by soft-tissue manipulation.

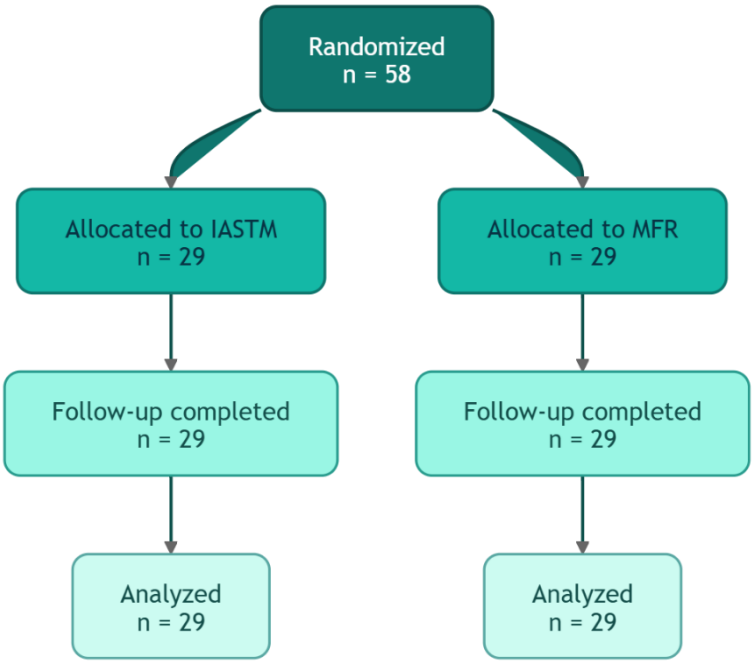

Figure 1 CONSORT Flowchart

The sample size was calculated using OpenEpi for comparison of two independent means on the basis of Neck Disability Index values reported in a previous study comparing IASTM and manual myofascial release, with expected group means of 17 and 22, a common standard deviation of 6, 95% confidence level, 80% statistical power, and equal allocation between groups (11). The calculation yielded 23 participants per group. After allowing for an anticipated 20% dropout rate, the final target sample size was increased to 29 participants per group, giving a total sample of 58 participants.

Eligible participants were informed about the study objectives, intervention procedures, potential discomfort, expected benefits, confidentiality protections, and their right to withdraw at any stage without penalty. Written informed consent was obtained before enrolment. After baseline measurement, participants were randomized in a 1:1 ratio to Group A or Group B by a computer-generated random allocation sequence. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes prepared and opened by an independent person who was not involved in outcome assessment. Group A received IASTM, whereas Group B received MFR. Because of the nature of manual therapy, participants and treating therapists could not be blinded to intervention allocation; however, outcome assessment was performed by an assessor who was unaware of treatment assignment. Participants were instructed not to disclose their intervention group to the assessor during follow-up measurements.

Baseline data included age, sex, height, weight, body mass index, dominant hand, physical activity level, DOMS onset duration in hours, pain intensity, neck-related disability, and cervical range of motion. Pain intensity in the cervicothoracic region was measured using a 10-cm Visual Analog Scale, where 0 represented no pain and 10 represented the worst imaginable pain (12). Functional disability was assessed using the Neck Disability Index, with higher scores indicating greater neck-related functional limitation (13). Cervical range of motion was measured in degrees using a universal goniometer for flexion, extension, right lateral flexion, left lateral flexion, right rotation, and left rotation. Measurements were obtained at baseline and after each of the three treatment sessions. The same assessment sequence and measurement tools were used for both groups to ensure procedural consistency.

Participants allocated to the IASTM group received instrument-assisted soft tissue mobilization to the cervicothoracic soft-tissue region. A small amount of gel or lotion was applied to reduce friction and allow smooth movement of the instrument over the skin. The treatment targeted the upper trapezius, levator scapulae, cervicothoracic paraspinal region, and adjacent soft tissues presenting with soreness, stiffness, or palpable restriction. Controlled unidirectional strokes were applied with moderate pressure for 8–10 minutes per session, once daily across three sessions during the DOMS period. Pressure was kept within participant tolerance, and the therapist monitored for excessive discomfort, bruising, skin irritation, dizziness, neurological symptoms, or any adverse response. Treatment was discontinued or modified if unusual pain or tissue reaction occurred. Participants allocated to the MFR group received manual myofascial release to the same cervicothoracic soft-tissue region. The therapist applied slow, sustained manual pressure and gentle stretch over the upper trapezius, levator scapulae, cervicothoracic paraspinal muscles, and related fascial restrictions until soft-tissue relaxation or reduction in resistance was perceived. Each session lasted 8–10 minutes, matching the IASTM group in treatment duration and number of sessions. The pressure was adjusted according to participant comfort and tissue response, and the same precautions were followed to prevent excessive discomfort, bruising, or aggravation of symptoms. Participants in both groups were advised not to receive additional physiotherapy, massage, manual therapy, analgesic medication, or other interventions for cervicothoracic soreness during the study period, so that outcome changes could be attributed as closely as possible to the assigned intervention protocol.

Data were recorded on structured data collection forms and then entered into a computerized spreadsheet before statistical analysis. Data quality was maintained through double-checking of entries, verification of outlying values against original forms, consistent coding of categorical variables, and use of standardized assessment procedures. Continuous variables were summarized as mean and standard deviation when approximately normally distributed, and categorical variables were summarized as frequency and percentage. Normality of continuous outcome variables was assessed using the Shapiro–Wilk test and visual inspection. Baseline comparability between groups was examined using the independent-samples t-test for normally distributed continuous variables, the Mann–Whitney U test for non-normally distributed continuous variables, and the chi-square test or Fisher's exact test for categorical variables, as appropriate.

The primary comparative analysis evaluated change over time between the IASTM and MFR groups using a 2 × 4 mixed-design repeated-measures analysis of variance, with time as the within-subject factor and treatment group as the between-subject factor. The four assessment points were baseline, after session 1, after session 2, and after session 3. The main outcomes were pain intensity, Neck Disability Index score, and cervical range of motion in flexion, extension, bilateral lateral flexion, and bilateral rotation. The time effect assessed overall change across sessions, the group effect assessed overall between-group difference, and the time × group interaction assessed whether the pattern of change differed between IASTM and MFR. Greenhouse–Geisser correction was applied when the sphericity assumption was violated. Post-hoc between-group comparisons at each time point were interpreted with attention to multiplicity, and treatment effects were reported using mean differences with 95% confidence intervals and Cohen's d where appropriate. Missing outcome values were checked before analysis; complete-case analysis was used when all scheduled assessments were available, and any missing data pattern was to be documented before final interpretation. Statistical significance was set at $p < 0.05$, and all analyses were performed using SPSS.

Ethical approval was obtained from the Ethics Committee of Green International University under approval number NCT07609498 The study was conducted according to standard ethical principles of autonomy, beneficence, non-maleficence, confidentiality, and justice. Participants were screened for contraindications before intervention, and treatment was delivered by a trained physiotherapist using clinically acceptable pressure and safety monitoring. Privacy was maintained during manual therapy procedures, and participants were allowed to request pauses or discontinue treatment at any time. Personal identifiers were kept confidential, and results were reported only in aggregate form. The study protocol was reviewed and approved by the relevant institutional ethics committee before data collection, and written informed consent was obtained from all participants.

RESULTS

A total of 58 participants were included and randomized equally into the IASTM group (n = 29) and MFR group (n = 29). The two treatment arms were comparable at baseline for sex distribution, dominant hand, physical activity level, age, weight, height, BMI, and DOMS onset duration, with all baseline between-group comparisons showing non-significant differences. Male participants comprised 44.8% of the IASTM group and 51.7% of the MFR group, while females comprised 55.2% and 48.3%, respectively. Mean age was 29.03 ± 2.61 years in the IASTM group and 28.76 ± 2.37 years in the MFR group, and DOMS onset duration was almost identical between groups at 41.20 ± 8.07 and 41.21 ± 7.82 hours, respectively. These findings indicate that the groups were well matched at enrolment, although baseline non-significance was interpreted as evidence of comparability rather than proof of complete absence of confounding.

Table 1. Baseline demographic, anthropometric, and clinical characteristics of participants by treatment group

Variable	Category / Unit	IASTM (n = 29)	MFR (n = 29)	Total (N = 58)	Test Statistic	Mean Difference Effect	p-value
Gender	Male, n (%)	13 (44.8)	15 (51.7)	28 (48.3)	$\chi^2 = 0.276$	—	0.599
	Female, n (%)	16 (55.2)	14 (48.3)	30 (51.7)			
Dominant hand	Right, n (%)	24 (82.8)	26 (89.7)	50 (86.2)	$\chi^2 = 0.580$	—	0.706
	Left, n (%)	5 (17.2)	3 (10.3)	8 (13.8)			
Physical activity level	Sedentary, n (%)	8 (27.6)	10 (34.5)	18 (31.0)	$\chi^2 = 0.717$	—	0.869
	Light, n (%)	12 (41.4)	9 (31.0)	21 (36.2)			
	Moderate, n (%)	7 (24.1)	8 (27.6)	15 (25.9)			
	Vigorous, n (%)	2 (6.9)	2 (6.9)	4 (6.9)			
Age	Years, mean ± SD	29.03 ± 2.61	28.76 ± 2.37	—	t = 0.421	0.28 years, 95% CI −1.04 to 1.59	0.675
Weight	kg, mean ± SD	66.24 ± 8.10	68.15 ± 8.53	—	t = −0.875	−1.91 kg, 95% CI −6.29 to 2.46	0.385
Height	cm, mean ± SD	164.63 ± 7.97	166.85 ± 6.17	—	t = −1.188	−2.22 cm, 95% CI −5.97 to 1.53	0.240
BMI	kg/m², mean ± SD	24.62 ± 3.95	24.56 ± 3.51	—	t = 0.065	0.06 kg/m², 95% CI −1.90 to 2.03	0.949
DOMS onset duration	Hours, mean ± SD	41.20 ± 8.07	41.21 ± 7.82	—	t = −0.005	−0.01 hours, 95% CI −4.19 to 4.17	0.996

The distribution of baseline and follow-up outcome data was assessed using the Shapiro–Wilk test. Most distributions met the normality assumption, including all pain and NDI distributions across both groups

and all four assessment points. Seven of 64 distributions showed statistically significant deviation from normality, mainly in selected cervical ROM variables. These deviations were isolated rather than systematic, and the primary analysis was therefore retained as a mixed-design repeated-measures ANOVA, with interpretation supported by inspection of effect estimates and confidence intervals.

Pain intensity decreased in both groups across the three intervention sessions, but the magnitude of reduction was consistently larger in the IASTM group after treatment began. At baseline, VAS scores were similar between groups, with a mean difference of 0.13 points (95% CI −0.15 to 0.41; p = 0.360). After session 1, the IASTM group had a lower mean VAS score than the MFR group by 0.87 points (95% CI −1.10 to −0.64; p < 0.001; Cohen's d = −1.97). The between-group difference increased to −1.06 points after session 2 and −1.27 points at final assessment, with both comparisons remaining statistically significant and showing very large standardized differences. Functional disability followed a similar pattern. Baseline NDI was comparable between groups, but final NDI was 6.10 ± 1.02 in the IASTM group compared with 9.78 ± 1.41 in the MFR group, corresponding to a mean difference of −3.68 points (95% CI −4.33 to −3.04; p < 0.001; Cohen's d = −3.00).

Table 2. Between-group comparison of pain, disability, and cervical range of motion across assessment time points

Outcome	Time Point	IASTM (n = 29), Mean ± SD	MFR (n = 29), Mean ± SD	Mean Difference (95% CI)	t-value	p-value	Cohen's d
Pain VAS, 0–10	Baseline	6.34 ± 0.63	6.21 ± 0.43	0.13 (−0.15 to 0.41)	0.923	0.360	0.24
	After session 1	3.88 ± 0.49	4.75 ± 0.38	−0.87 (−1.10 to −0.64)	−7.510	<0.001	−1.97
	After session 2	2.47 ± 0.36	3.54 ± 0.34	−1.06 (−1.25 to −0.88)	−11.662	<0.001	−3.06
	Final	1.45 ± 0.31	2.72 ± 0.35	−1.27 (−1.44 to −1.10)	−14.724	<0.001	−3.87
NDI score	Baseline	23.00 ± 2.92	22.28 ± 2.82	0.72 (−0.79 to 2.22)	0.950	0.346	0.25
	After session 1	14.81 ± 1.81	17.52 ± 1.66	−2.71 (−3.63 to −1.80)	−5.948	<0.001	−1.56
	After session 2	9.55 ± 1.74	13.61 ± 1.64	−4.06 (−4.95 to −3.17)	−9.147	<0.001	−2.40
	Final	6.10 ± 1.02	9.78 ± 1.41	−3.68 (−4.33 to −3.04)	−11.408	<0.001	−3.00
Cervical flexion, degrees	Baseline	35.14 ± 3.20	35.83 ± 3.15	−0.69 (−2.36 to 0.98)	−0.829	0.410	−0.22
	After session 1	42.60 ± 1.98	41.19 ± 1.87	1.41 (0.40 to 2.43)	2.790	0.007	0.73
	After session 2	48.57 ± 2.45	45.08 ± 1.83	3.50 (2.36 to 4.64)	6.148	<0.001	1.61
	Final	53.65 ± 1.71	49.02 ± 2.20	4.64 (3.60 to 5.67)	8.970	<0.001	2.36
Cervical extension, degrees	Baseline	39.71 ± 4.05	38.79 ± 3.44	0.92 (−1.06 to 2.89)	0.930	0.356	0.24
	After session 1	48.33 ± 2.50	45.83 ± 2.68	2.50 (1.13 to 3.86)	3.669	0.001	0.96
	After session 2	54.79 ± 2.15	50.68 ± 2.20	4.12 (2.97 to 5.26)	7.206	<0.001	1.89
	Final	59.43 ± 2.44	54.42 ± 2.18	5.01 (3.79 to 6.23)	8.238	<0.001	2.16
Right lateral flexion, degrees	Baseline	29.51 ± 3.02	30.38 ± 2.96	−0.87 (−2.44 to 0.70)	−1.106	0.273	−0.29
	After session 1	36.41 ± 2.40	34.94 ± 1.93	1.47 (0.33 to 2.62)	2.578	0.013	0.68
	After session 2	41.26 ± 2.30	38.63 ± 1.48	2.63 (1.61 to 3.65)	5.189	<0.001	1.36
	Final	45.47 ± 2.03	41.73 ± 1.66	3.75 (2.77 to 4.72)	7.702	<0.001	2.02
Left lateral flexion, degrees	Baseline	29.61 ± 3.80	30.33 ± 3.76	−0.72 (−2.71 to 1.27)	−0.724	0.472	−0.19
	After session 1	36.12 ± 2.12	34.47 ± 2.59	1.65 (0.41 to 2.90)	2.655	0.010	0.70
	After session 2	40.90 ± 1.65	38.02 ± 2.69	2.88 (1.70 to 4.05)	4.912	<0.001	1.29
	Final	44.74 ± 1.52	41.19 ± 2.69	3.55 (2.39 to 4.70)	6.188	<0.001	1.62
Right rotation, degrees	Baseline	52.79 ± 5.03	53.12 ± 5.51	−0.32 (−3.10 to 2.45)	−0.234	0.816	−0.06
	After session 1	61.77 ± 3.13	60.05 ± 3.23	1.72 (0.04 to 3.39)	2.057	0.044	0.54
	After session 2	67.40 ± 2.69	64.62 ± 2.98	2.78 (1.28 to 4.27)	3.724	<0.001	0.98
	Final	75.03 ± 3.03	68.96 ± 3.31	6.07 (4.40 to 7.74)	7.288	<0.001	1.91
Left rotation, degrees	Baseline	52.90 ± 4.82	53.19 ± 5.69	−0.29 (−3.07 to 2.48)	−0.211	0.833	−0.06
	After session 1	62.16 ± 3.66	59.74 ± 3.19	2.42 (0.62 to 4.23)	2.686	0.010	0.71
	After session 2	68.31 ± 3.40	64.68 ± 2.79	3.64 (2.00 to 5.27)	4.455	<0.001	1.17
	Final	74.71 ± 2.78	69.47 ± 2.99	5.24 (3.72 to 6.76)	6.913	<0.001	1.82

Cervical range of motion improved in both groups, but post-treatment gains were consistently greater following IASTM. At baseline, no cervical ROM measure differed significantly between groups, with p-values ranging from 0.273 to 0.833. After treatment began, the IASTM group showed greater gains across all six movement directions. At final assessment, the largest absolute between-group difference was observed for right cervical rotation, where IASTM reached 75.03 ± 3.03° compared with 68.96 ± 3.31° in the MFR group, giving a mean difference of 6.07° (95% CI 4.40 to 7.74; p < 0.001; Cohen's d = 1.91). Final extension was also higher in the IASTM group by 5.01° (95% CI 3.79 to 6.23; p < 0.001; Cohen's d = 2.16), while final flexion was higher by 4.64° (95% CI 3.60 to 5.67; p < 0.001; Cohen's d = 2.36). Bilateral lateral flexion and rotation showed a symmetrical pattern of improvement, with final IASTM advantages ranging from 3.55° to 6.07° across these planes.

Within-group change analysis showed that both interventions produced clinically meaningful improvement from baseline to final assessment. In the IASTM group, pain decreased by 4.89 points, representing a 77.1% reduction, while NDI decreased by 16.90 points, representing a 73.5% reduction. Cervical ROM gains in the IASTM group ranged from 15.13° for left lateral flexion to 22.24° for right rotation, with percentage improvements ranging from 41.2% to 54.1%. In the MFR group, pain decreased by 3.49 points, representing a 56.2% reduction, and NDI decreased by 12.50 points, representing a 56.1% reduction. ROM gains in the MFR group ranged from 10.87° for left lateral flexion to 16.28° for left rotation, with percentage improvements ranging from 29.8% to 40.3%. Thus, both interventions were associated with improvement, but the magnitude of improvement was consistently larger in the IASTM group.

Table 3. Within-group change from baseline to final assessment

Outcome	IASTM Baseline Mean ± SD	IASTM Final Mean ± SD	IASTM Change	IASTM % Change	MFR Baseline Mean ± SD	MFR Final Mean ± SD	MFR Change	MFR % Change
Pain VAS, 0–10	6.34 ± 0.63	1.45 ± 0.31	−4.89	−77.1%	6.21 ± 0.43	2.72 ± 0.35	−3.49	−56.2%
NDI score	23.00 ± 2.92	6.10 ± 1.02	−16.90	−73.5%	22.28 ± 2.82	9.78 ± 1.41	−12.50	−56.1%
Cervical flexion, degrees	35.14 ± 3.20	53.65 ± 1.71	+18.51	+52.7%	35.83 ± 3.15	49.02 ± 2.20	+13.18	+36.8%
Cervical extension, degrees	39.71 ± 4.05	59.43 ± 2.44	+19.72	+49.6%	38.79 ± 3.44	54.42 ± 2.18	+15.63	+40.3%
Right lateral flexion, degrees	29.51 ± 3.02	45.47 ± 2.03	+15.96	+54.1%	30.38 ± 2.96	41.73 ± 1.66	+11.35	+37.4%
Left lateral flexion, degrees	29.61 ± 3.80	44.74 ± 1.52	+15.13	+51.1%	30.33 ± 3.76	41.19 ± 2.69	+10.87	+35.8%
Right rotation, degrees	52.79 ± 5.03	75.03 ± 3.03	+22.24	+42.1%	53.12 ± 5.51	68.96 ± 3.31	+15.85	+29.8%
Left rotation, degrees	52.90 ± 4.82	74.71 ± 2.78	+21.81	+41.2%	53.19 ± 5.69	69.47 ± 2.99	+16.28	+30.6%

The mixed-design repeated-measures ANOVA demonstrated statistically significant time effects for all outcomes, confirming that both groups improved across the four assessment points. Significant time × group interactions were also observed for all outcomes, indicating that the pattern and magnitude of improvement differed between the two interventions.

The strongest interaction effect was observed for pain VAS, with $F = 34.70$ and $p < 0.001$, followed by NDI, cervical flexion, and right lateral flexion. Group main effects were statistically significant for all variables, showing overall separation between IASTM and MFR across the repeated measurements. These omnibus findings support the pattern observed in the descriptive and pairwise comparisons, in which IASTM produced larger short-term improvements than MFR across pain, disability, and cervical mobility outcomes.

Table 4. Mixed-design repeated-measures ANOVA summary for treatment effects across time

Outcome	Time Effect F (df)	Time Effect p-value	Time × Group F (df)	Time × Group p-value	Group Main Effect F (df)	Group Main Effect p-value
Pain VAS	1189.22 (2.51, 140.45)	<0.001	34.70 (2.51, 140.45)	<0.001	149.46 (1, 56)	<0.001
NDI	624.43 (2.24, 125.29)	<0.001	18.40 (2.24, 125.29)	<0.001	77.91 (1, 56)	<0.001
Cervical flexion	594.06 (2.49, 139.27)	<0.001	17.78 (2.49, 139.27)	<0.001	32.24 (1, 56)	<0.001
Cervical extension	532.59 (2.22, 124.48)	<0.001	7.43 (2.22, 124.48)	0.001	48.25 (1, 56)	<0.001
Right lateral flexion	504.86 (2.22, 124.57)	<0.001	14.27 (2.22, 124.57)	<0.001	19.76 (1, 56)	<0.001
Left lateral flexion	428.66 (1.78, 99.71)	<0.001	12.05 (1.78, 99.71)	<0.001	11.59 (1, 56)	0.001
Right rotation	330.64 (2.07, 115.99)	<0.001	9.06 (2.07, 115.99)	<0.001	17.43 (1, 56)	<0.001
Left rotation	357.40 (2.19, 122.50)	<0.001	7.39 (2.19, 122.50)	0.001	17.28 (1, 56)	<0.001

Across the complete outcome profile, the greatest relative improvement in the IASTM group was observed for right lateral flexion, which increased by 54.1%, followed by cervical flexion at 52.7%, left lateral flexion at 51.1%, and cervical extension at 49.6%.

The largest absolute ROM gains occurred in rotational movements, with right rotation increasing by 22.24° and left rotation by 21.81°. In the MFR group, the largest percentage improvement was observed for cervical extension at 40.3%, followed by right lateral flexion at 37.4% and cervical flexion at 36.8%, while rotational improvements remained smaller at approximately 30%. This pattern suggests that both

interventions improved pain, disability, and mobility over time, but IASTM showed a broader and stronger improvement gradient across both sagittal and rotational movement planes.

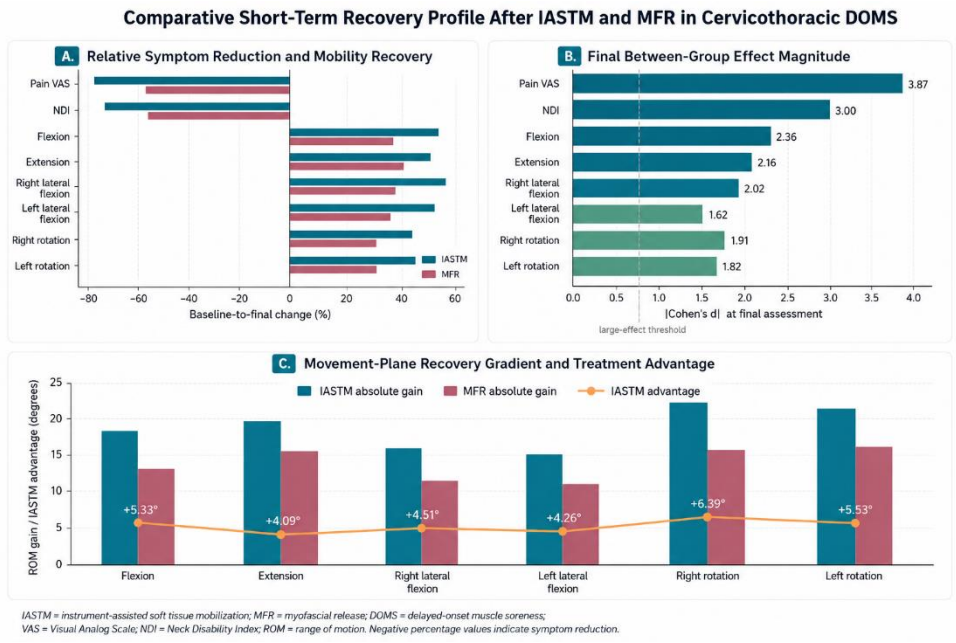

Figure 2 Comparative Short-Term Recovery Profile After IASTM and MFR in Cervicothoracic DOMS.

The panelled figure demonstrates a consistent recovery advantage for IASTM across symptom and mobility domains. Pain decreased by 77.1% after IASTM compared with 56.2% after MFR, while NDI improved by 73.5% versus 56.1%, respectively. Final between-group standardized effects were very large for pain (|d| = 3.87), NDI (|d| = 3.00), cervical flexion (d = 2.36), extension (d = 2.16), and right lateral flexion (d = 2.02), with all remaining ROM outcomes also exceeding the large-effect threshold. Movement-plane analysis showed that IASTM produced greater absolute ROM recovery than MFR in every direction, with the largest treatment advantage observed for right rotation (+6.39°), followed by left rotation (+5.53°), flexion (+5.33°), right lateral flexion (+4.61°), left lateral flexion (+4.26°), and extension (+4.09°). This integrated pattern indicates that IASTM provided broader short-term recovery, particularly for rotational mobility and symptom reduction, while MFR remained beneficial but consistently less pronounced across the assessed outcomes.

DISCUSSION

This randomized controlled trial compared the short-term effects of instrument-assisted soft tissue mobilization and myofascial release on pain intensity, neck-related disability, and cervical range of motion in adults with cervicothoracic delayed-onset muscle soreness. The principal finding was that both interventions were associated with statistically significant improvement across pain, disability, and all measured cervical movement directions over three treatment sessions, but the magnitude and rate of improvement were consistently greater in the IASTM group. Pain intensity decreased by 77.1% after IASTM compared with 56.2% after MFR, while NDI improved by 73.5% and 56.1%, respectively. The final between-group differences were also clinically meaningful, with IASTM showing lower final VAS scores by 1.27 points and lower final NDI scores by 3.68 points. Cervical ROM improved in all planes in both groups, but IASTM produced larger absolute gains, particularly in rotational movements, where right rotation improved by 22.24° in the IASTM group compared with 15.85° in the MFR group, and left rotation improved by 21.81° compared with 16.28°. These findings suggest that both soft-tissue techniques may support short-term recovery in cervicothoracic DOMS, while IASTM showed a broader and stronger response pattern under the tested protocol.

The superiority of IASTM observed in the present trial is consistent with prior evidence suggesting that instrument-assisted techniques may reduce pain and improve functional outcomes in musculoskeletal soft-tissue conditions. Systematic reviews have reported beneficial short-term effects of IASTM on pain, function, and range of motion in musculoskeletal populations, although the magnitude of benefit varies according to condition, treatment dose, comparator intervention, and outcome measure (14,15). The present study extends this evidence to cervicothoracic DOMS, a short-duration post-exercise condition that differs from chronic neck pain and persistent myofascial pain syndromes in its natural history, tissue irritability, and expected recovery trajectory. The larger reduction in VAS and NDI following IASTM may reflect a combination of mechanical, neurophysiological, and perceptual effects, including altered nociceptive input, improved soft-tissue glide, and reduced movement-related apprehension, although these mechanisms were not directly measured in the present study and should therefore be interpreted as plausible explanations rather than confirmed biological pathways.

The observed improvement after MFR is also clinically relevant. Participants receiving MFR showed a 56.2% reduction in pain, a 56.1% reduction in NDI, and ROM gains ranging from 10.87° to 16.28°. These results support the therapeutic value of manual myofascial techniques for cervicothoracic soreness and are consistent with previous studies reporting improvement in pain, disability, and cervical mobility after MFR-based interventions in neck pain and myofascial conditions (7,10,16). However, the comparatively smaller gains in the MFR group indicate that, within this three-session protocol, manual sustained pressure and fascial release produced less pronounced short-term change than instrument-assisted mobilization. This does not imply that MFR is ineffective; rather, it suggests that IASTM may have produced a stronger short-term response in this specific population, anatomical region, and dosing schedule.

The movement-plane pattern provides additional clinical insight. Both groups improved across flexion, extension, lateral flexion, and rotation, but the largest absolute gains after IASTM occurred in cervical rotation, with right and left rotation increasing by more than 21°. Rotational movement may be particularly sensitive to cervicothoracic soft-tissue restriction because it depends on coordinated mobility across the cervical spine, upper thoracic region, scapular stabilizers, and surrounding fascial structures. The larger rotational advantage after IASTM may therefore indicate improved tolerance to multiplanar movement and reduced soft-tissue resistance in the cervicothoracic region. However, because tissue stiffness, muscle activation, fascial hydration, and imaging-based mobility were not measured, this interpretation remains clinical rather than mechanistic. Future studies incorporating ultrasound elastography, electromyography, pressure pain threshold, or tissue perfusion measures would help clarify whether the observed ROM gains reflect true tissue-level change, altered pain modulation, or both.

The repeated-measures ANOVA confirmed significant time effects for all outcomes, indicating that participants improved across sessions irrespective of group. Significant time × group interactions further demonstrated that the pattern of improvement differed between interventions, favoring IASTM. Nevertheless, interpretation of these findings should consider the natural course of DOMS. DOMS is typically self-limiting and often improves over several days even without intervention (1,3). Because the present trial compared two active interventions without a sham, no-treatment, or usual-care control group, it cannot fully separate treatment-related improvement from spontaneous recovery. The consistent superiority of IASTM over MFR supports a relative treatment advantage, but the absolute improvement observed in both groups may partly reflect the expected resolution of DOMS over time. This limitation is important because the final follow-up occurred after only three sessions and does not establish whether benefits persisted beyond the acute recovery period.

The study has several strengths. Random allocation produced comparable groups at baseline for demographic, anthropometric, activity-related, and clinical variables, with no statistically significant between-group differences before intervention. The use of assessor blinding reduced measurement bias,

and the repeated assessment of VAS, NDI, and six cervical ROM directions allowed a multidimensional evaluation of pain, disability, and mobility. The reporting of mean differences, 95% confidence intervals, p-values, and standardized effect sizes also improves the clinical interpretability of the findings. However, several limitations must be acknowledged. The study was conducted at a single clinical center with a relatively narrow age range of 25–35 years, which limits generalizability to adolescents, older adults, athletes, sedentary workers, or patients with chronic neck pain. The sample size was adequate for the planned comparison but underpowered for subgroup analyses by sex, physical activity level, baseline pain severity, or DOMS duration. The intervention period was short, and no medium- or long-term follow-up was included. Pain and disability were measured using self-reported instruments, and ROM assessment with a goniometer may be influenced by assessor technique despite blinding. The study also did not include objective biological or biomechanical measures, so mechanistic conclusions cannot be drawn.

Another methodological consideration is multiplicity. The trial assessed multiple outcomes across several time points, including pain, disability, and six ROM directions. Although the pattern of results was consistent and statistically strong, future trials should prespecify a single primary outcome, preferably final VAS or change in VAS, and designate NDI and ROM measures as secondary outcomes. This would reduce the risk of inflated type I error and improve interpretive hierarchy. Larger multicenter trials should also include a sham or minimal-intervention control group to quantify the contribution of natural DOMS recovery. Standardization of IASTM tool type, stroke direction, treatment angle, pressure intensity, therapist training, and MFR release criteria would further improve reproducibility. Patient satisfaction, adverse events, cost-effectiveness, and return-to-activity outcomes may also provide useful information for clinical decision-making.

Overall, the findings indicate that IASTM and MFR were both associated with meaningful short-term improvements in cervicothoracic DOMS, but IASTM produced greater reductions in pain and disability and larger improvements in multidirectional cervical ROM. These results support the clinical use of IASTM as a potentially more effective short-term manual therapy option than MFR for adults presenting with acute cervicothoracic DOMS, while recognizing that the absence of a non-treatment control group prevents definitive conclusions about absolute efficacy beyond natural recovery.

CONCLUSION

Instrument-assisted soft tissue mobilization and myofascial release were both associated with significant short-term improvement in pain intensity, neck-related disability, and cervical range of motion among adults with cervicothoracic delayed-onset muscle soreness. Under the tested three-session protocol, IASTM produced consistently greater improvement than MFR, with larger reductions in VAS and NDI scores and greater gains across flexion, extension, bilateral lateral flexion, and bilateral rotation. The findings suggest that IASTM may be a more effective short-term manual therapy approach for cervicothoracic DOMS than MFR; however, interpretation should remain cautious because DOMS is naturally self-limiting, the study lacked a sham or no-treatment control group, and no long-term follow-up or objective tissue-level outcomes were included.

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