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Effect of Muscle Energy Technique on Cervical Pain and Heading Performance in Recreational Football Players: A Randomized Controlled Trial

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Abstract

Background: Recreational football players often experience cervical discomfort and reduced functional performance due to repetitive heading and inadequate neck conditioning. While multiple therapeutic approaches are available to address cervical pain and dysfunction, Muscle Energy Technique (MET), a form of manual therapy, has emerged as a potentially effective intervention, offering therapeutic benefits for enhancing cervical function and optimizing sport-specific performance. This study aims to evaluate the effectiveness of MET in reducing cervical pain and enhancing heading performance among recreational football players thereby promoting good health and overall well-being. **Methods:** This randomized controlled trial included 30 recreational football players, with 15 in MET group and 15 in the control group. The MET group received Muscle Energy Technique in combination with conventional therapy, while the control group underwent only conventional therapy for 45 minutes per session, three times per week, over a period of four weeks. Pre- and post-treatment assessments included Numeric Pain Rating Scale (NPRS), F-MARC battery test, Cervical range of motion (ROM) and Manual muscle testing. Data were analyzed with the level of significance set at $p < 0.05$. **Results:** Participants in both groups showed statistically significant reductions in cervical pain intensity but a greater gain was found in the MET group of 5.27 ± 1.49 to 2.53 ± 1.25. In the MET group (Group A), the mean front-sided heading score improved markedly from 1.80 ± 1.21 at baseline to 4.93 ± 1.58 post-intervention, showing a statistically significant improvement ($p < 0.001$). Similarly, the mean right-sided heading score increased from 1.93 ± 1.87 to 4.27 ± 1.75, which was also statistically significant ($p < 0.001$). Similarly, the participants in MET group (Group A), had a highly significant improvement ($p < 0.001$) in all directions of cervical movement and cervical muscle strength after treatment as compared to control group. **Conclusion:** Muscle Energy Technique is an effective and safe intervention for reducing cervical pain and improving heading performance in recreational football players.

Major Findings: Muscle Energy Technique resulted in greater reductions in cervical pain and Greater improvements in heading performance and cervical function compared to conventional physiotherapy alone.

Keywords: Cervical Pain, Cervical Strength, Heading Performance, Muscle Energy Technique, Recreational Football, Range of Motion, Well-being

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1. Introduction

Cervical pain is a common musculoskeletal disorder that significantly impacts both the general population and athletes, particularly those participating in sports involving repetitive or high-impact movements[1]. In football, cervical strain and discomfort are prevalent due to actions such as heading the ball, sudden directional changes, physical collisions, and prolonged periods of inadequate posture during training[2]. These problems are especially pronounced among recreational football players, who often lack structured training programs,

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coaching supervision, or access to professional physiotherapy. Recurrent neck pain, stiffness, and reduced functional mobility negatively affect performance and may have long-term health consequences[3].

Cervical musculoskeletal disorders are a leading cause of disability and reduced productivity globally[4]. In India and worldwide, sports-related cervical injuries contribute to increasing healthcare costs and lost participation in physical activity, highlighting a pressing public health concern[5]. The cumulative economic burden of untreated or inadequately managed cervical pain—including medical expenses, physiotherapy sessions, and lost work or sport participation—emphasizes the need for accessible, cost-effective interventions[6].

While multiple therapeutic approaches are available to address cervical pain and dysfunction, Muscle Energy Technique (MET), a type of osteopathic manual therapy, has emerged as a non-invasive and effective approach for managing cervical pain. MET involves voluntary isometric muscle contractions performed by the patient against a therapist-applied counterforce, promoting muscle relaxation, joint mobilization, and increased range of motion[7]. It is safe, simple, and effective in improving joint mobility, muscle flexibility, and pain perception[8]. The technique is based on neurophysiological principles such as post-isometric relaxation and reciprocal inhibition[9], which not only relieve musculoskeletal pain but also restore optimal biomechanical function.

Heading in football is a biomechanically demanding skill requiring neck strength, coordination, and timing. Poor technique or excessive repetition without proper conditioning can lead to cumulative cervical strain[10]. While most research focuses on elite athletes, recreational football players—who often lack injury-prevention strategies and physiotherapy support—are equally, if not more, susceptible to cervical injuries[4]. This underlines the need for practical, evidence-based interventions that are effective at both community and competitive levels[8-10].

Conventional management strategies, including passive rest, NSAIDs, and standard exercise regimens, often produce limited benefits or unintended adverse effects[11]. Research specifically investigating MET's effect on cervical pain and sports-specific tasks such as heading in recreational football players remains limited, representing a critical gap in the literature.

Thus, this study primarily aims to evaluate the efficacy of Muscle Energy Technique (MET) in reducing cervical pain and enhancing heading performance among recreational football players by comparing outcomes between the intervention and control groups. Secondarily, it aims to assess the effect of MET on cervical range of motion and muscle strength. Furthermore, the study seeks to establish MET as a cost-effective and accessible therapeutic approach that can be implemented by trained physiotherapists in community-level sports settings. By incorporating functional outcome measures such as heading accuracy and power, this study bridges the gap between pain management and performance enhancement.

The study also proposes improvements to current physiotherapy protocols based on literature evidence, including structured MET programs targeting cervical muscles and sport-specific functional outcomes. Implementation of these protocols may improve postural alignment, neuromuscular control, and injury resilience, thereby the good health and well-being of both recreational and professional athletes.

Primary Outcomes: Cervical pain intensity (NPRS) and heading performance.

Secondary Outcomes: Cervical range of motion and cervical muscle strength.

2. Materials and Methods

A Randomized Controlled Trial (RCT) was undertaken at various football clubs and academies across South Bengaluru between April 2024 to May 2025 after obtaining approval from The Scientific Committee and Institutional Ethical Committee of College of Physiotherapy, School of Health Sciences, Dayananda Sagar University, Bengaluru (IEC/IRB/DSU/MPT/2024/016).

A Sample Size of 30 participants (15 per group) was estimated using paired t-test estimates with effect size = 0.75, $\alpha = 0.05$, power = 80%, accounting for 10% dropout. After obtaining the necessary permissions from recreational football clubs and academies from south Bengaluru region, male and female recreational football players were approached for participation. The study's purpose was explained to those willing to participate, and written informed consent was obtained. Eligible participants were then screened according to the inclusion and exclusion criteria, and demographic data were collected.

The inclusion criteria included male and female recreational football players aged between 18–35 years with a frequency of 2–5 sessions/week and experiencing

cervical discomfort or pain during/after football activity. Exclusion criteria included history of cervical spine surgery, chronic systemic illness, neurological disorders, acute musculoskeletal injuries or deformities and medications affecting neuromuscular or cardiovascular function.

The participants (N=30) who fulfilled the study criteria were allocated into Group A=MET group (n=15) and Group B= Control group (n=15) using a simple randomization method on a computer-generated random number table prepared by an independent individual not involved in recruitment or assessment. Allocation concealment was ensured using sealed, opaque envelopes, which were opened only after baseline assessment. Baseline assessments were conducted prior to the intervention. Cervical pain intensity was assessed using the Numerical Pain Rating Scale (NPRS), Heading performance using a Heading component of F-MARC Battery Test. This was performed using two types of drills: forward heading and right-side heading, where each participant was asked to perform six heading attempts in each direction. Each attempt was scored based on accuracy, control, and follow-through, with observations made by a qualified physiotherapist and an experienced football coach. Additionally, the Cervical Range of Motion (ROM) was evaluated using the universal goniometer and Cervical muscle strength by Manual Muscle Testing (MMT).

2.1 Testing Procedure

All participants underwent standardized baseline and post-intervention assessments, carried out by a blinded assessor.

2.2 Pain Assessment

Numerical Pain Rating Scale (NPRS)

A 0–10 scale, with 0 = no pain and 10 = worst imaginable pain

Participants rated their current pain, average pain over last 24 hours, and worst pain experienced.

2.3 Heading Performance Assessment[12]

F-MARC heading test- A standardized heading test developed based on football training protocols. Heading performance was assessed using the heading component of the FIFA Medical Assessment and Research Centre (F-MARC) football test battery, following the scoring protocol described by Abraham *et al.* (2022). Forward and right-sided heading tasks were performed. Scoring was based on predefined goal segments with scores of 6, 3, 1, and 0 assigned according to accuracy as per the published protocol. Heading performance was assessed by a physiotherapist and an experienced football coach together.Both assessors jointly observed each performance and arrived at a final score through mutual consensus.

2.4 Forward Heading Test

The ball was tossed at chest height, and the participant was instructed to head the ball forward to a target zone (3 m away).

Accuracy, control, and follow-through were observed and rated out of 5.

2.5 Right-Side Heading Test

The participant performed side-heading toward a designated cone on the right side. Technique, direction, and power were scored similarly. Each test was repeated 3 times, and the average score was taken. Scoring was done by an experienced football coach and a physiotherapist using a pre-defined rubric.

2.6 Cervical Range of Motion (ROM) Assessment

Measured using a universal goniometer. Movements tested: Flexion, extension, right and left lateral flexion, right and left rotation Procedure:

Participant seated with spine in neutral

ROM measured thrice per direction, and the mean value was recorded.

2.7 Cervical Muscle Strength Testing

Assessed using Manual Muscle Testing (MMT)- Muscles assessed- Flexors (longus colli/capitis), Extensors (semispinalis capitis, upper trapezius), Lateral flexors (scalene), Rotators (sternocleidomastoid). Performed with standard resistance placement and against gravity. Cervical muscle strength was assessed using Manual Muscle Testing (MMT). Although MMT is an ordinal scale, parametric statistical analysis was applied as the data approximated normal distribution; this has been acknowledged as a methodological consideration.

2.8 Intervention

Group A: Muscle Energy Technique + Conventional Therapy-Participants in Group A received Muscle

Energy Technique (MET) as the primary intervention, in addition to the conventional therapy protocol. The MET was administered as shown in Figure 5 and Figure 6 by a trained physiotherapist following the standard Post-Isometric Relaxation (PIR) principle. The technique was applied to the upper trapezius and levator scapulae muscles for five repetitions, each involving approximately 20% of maximal isometric contraction. Following the isometric phase, the muscles were passively stretched beyond the resistance barrier and held for 20 seconds[13].

2.8.1 Procedure[13]

1. Positioning: The participant was supine with neck supported.
2. Muscle placed at its barrier: The therapist gently moved the head until a mild resistance was felt (end-range without pain).
3. Isometric Contraction: Participant was instructed to push gently against therapist resistance (20–% max effort); Hold time: 7–10 seconds.
4. Relaxation Phase: Participant was asked to relax completely.
5. Stretching: Therapist passively moved the head further into the new barrier.
6. Repetition: 3–5 times per muscle, per session.

The intervention was administered for a period of 4 weeks, consisting of three sessions per week, totaling 12 sessions.

2.8.2 Conventional Therapy (Same as Group B)

In addition to MET, participants in Group A also received:

10-minute moist hot pack

Cervical ROM exercises (10 reps × 2 sets, twice daily)

Cervical isometrics (5 sec hold × 10 reps × 2 sets, once daily)

Scapular stabilizing exercises (10–15 reps × 2 sets)

Postural training and ergonomic advice.

Group B: Conventional Therapy (Control Group)- Participants in the control group received only conventional physiotherapy, aimed at relieving cervical

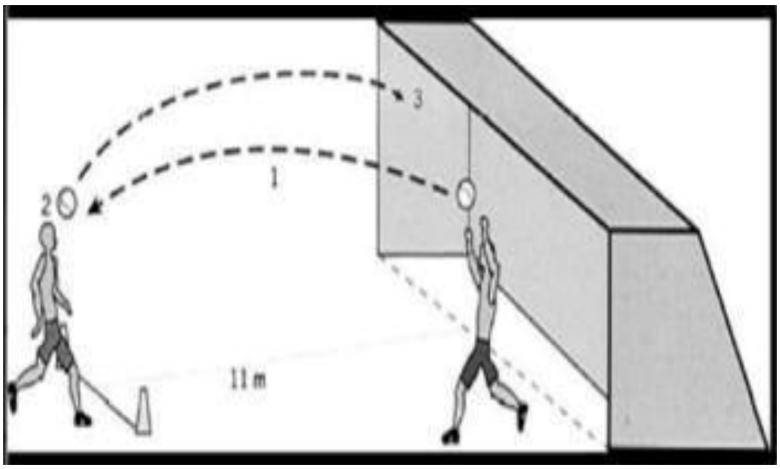


Figure 1. Front side heading[12].



Figure 2. Front side heading.

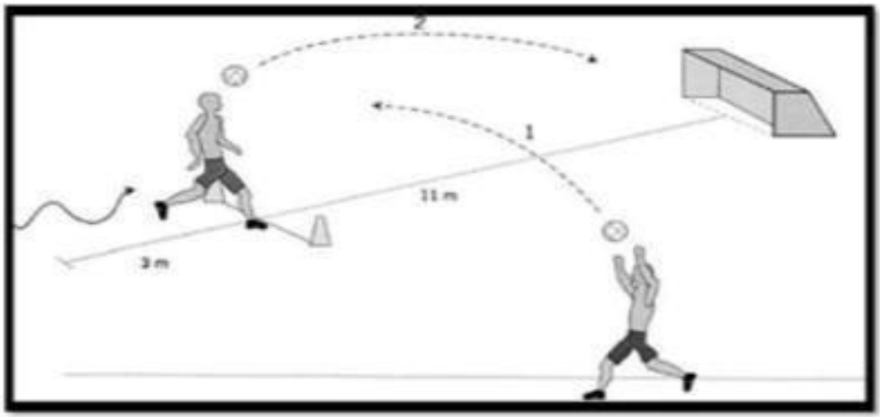


Figure 3. Right side heading[12].



Figure 4. Right side heading.



Figure 5. MET for upper trapezius.



Figure 6. MET for levator scapulae.

pain, restoring range of motion, and maintaining functional strength. This intervention did not include any manual therapy such as MET.

2.9 Superficial Heat Therapy

Modality: Moist Hot Pack

Application site: Posterior cervical and upper trapezius region

Duration: 10 minutes per session

Purpose: To increase tissue extensibility, reduce muscle spasm, and promote local circulation prior to exercise

2.10 Cervical Range of Motion (ROM) Exercises

These were taught and supervised by the physiotherapist in the clinic, and then assigned as a home program.

Movements Included

a) Flexion
b) Extension
c) Right and left lateral flexion
d) Right and left rotation

Exercise Prescription

a) **Repetitions**: 10 reps per direction
b) **Sets**: 2 sets per session
c) **Frequency**: Twice daily (morning and evening)
d) **Duration per session**: ~5 minutes
e) **Instructions**: Movements were to be performed slowly and within pain-free range, avoiding jerks or compensations.

Cervical Isometric Strengthening Exercises

These exercises target the deep and superficial neck muscles without changing the joint angle. The aim is to improve static stability and muscle endurance, especially important in heading performance.

Directions

a) Isometric flexion (hand against forehead)
b) Isometric extension (hand against the back of head)
c) Isometric lateral flexion (hand against the side of the head, both sides)
d) Isometric rotation (hand against the temple, resisting turning of the head to both sides)

Exercise Prescription

a) **Hold time**: 5 seconds per contraction
b) **Repetitions**: 10 reps per direction
c) **Sets**: 2 sets
d) **Frequency**: Once daily (performed after ROM exercises)
e) **Instructions**: Avoid breath-holding (no Valsalva), engage core for trunk stability during neck work

Scapular Stabilization Exercises

This help reduce cervical load by enhancing the function of the scapular muscles, particularly relevant in football players who often maintain forward-head posture.

Exercises Included

a. Shoulder shrugs (upper trapezius activation)
b. Scapular retraction in sitting or prone (middle trapezius, rhomboids)
c. Wall push-ups with scapular protraction
d. "W" position scapular squeezes

Exercise Prescription

Repetitions: 10–15 reps per exercise

Sets: 2 sets

Frequency: Twice daily

Progression: Introduced gradually based on pain tolerance and postural control.

Postural and Ergonomic Education: Participants were educated about:

a) Avoiding prolonged neck flexion (e.g., looking at phones)
b) Correct heading posture during football practice
c) Proper warm-up and cooldown for neck musculature
d) Advice on sleeping posture (supportive pillows)[36]

Total Duration- 4 weeks- 3 times per week (12 sessions in total). Session duration: ~35-45 minutes.

3. Statistical Analysis

The collected data was analyzed using SPSS software (SPSS Inc.; Chicago, IL) version 29.0.10. The Independent sample "t" test was used to compare age, duration of playing, and frequency of play in a week, NPRS, Range of Motion (ROM), heading performance, and cervical muscle strength; between the groups: MET and conventional, as well as according to gender. The Paired "t" test was used to compare NPRS, Range of Motion (ROM), heading performance, and cervical muscle strength within the groups, as well as irrespective of the groups. The partial eta square as well as Cohen's d were obtained to compute the effect size. To compare effectiveness of the interventions (Pre-Post) in NPRS, Range of Motion (ROM), heading performance, and cervical muscle strength; between the groups; the independent sample "t" test was used. The Chi square test was used to compare gender; between the groups. To find the relation between NPRS, Range of Motion (ROM), heading performance, and cervical muscle strength; the Pearson correlation coefficient: ("r") was used. The Shapiro-Wilk test was used to identify the normality of the data. The p value < 0.05 was considered as significant.

4. Results

A total of 30 participants allocated to Group A= MET (n=15) and Group B= Control= (n=15) with mean age of 23.63 ± 5.72 years. Groups were comparable in baseline demographics showing no difference ($p > 0.05$) in the age, duration of playing, as well as frequency of play in a week; between the groups: MET and conventional as depicted in Table 1.

The Table 2 shows the comparison of pain intensity scores measured using the Numerical Pain Rating Scale (NPRS) for two groups — Group A (MET) and Group B (Control) — before and after the intervention.

In Group A (MET), the mean NPRS score before treatment was 5.27 ± 1.49, which reduced to 2.53 ± 1.25 after treatment. The mean difference in pain scores was 2.73, and the change was statistically significant ($p < 0.001$).

In Group B (Control), the mean NPRS score before treatment was 5.33 ± 1.54, which decreased to 2.80 ± 1.61 after treatment. The mean difference was 2.53, and this reduction was also statistically significant ($p < 0.001$). This indicates that both the MET and control interventions led to a significant reduction in pain intensity, but the reduction was slightly greater in the MET group compared to the control group.

The Table 3 presents the pre- and post-intervention scores for front-sided and right-sided heading performance among recreational football players in both the MET and control groups.

In the MET group (Group A), the mean front-sided heading score improved markedly from 1.80 ± 1.21 at baseline to 4.93 ± 1.58 post-intervention, showing a statistically significant improvement ($p < 0.001$). Similarly, the mean right-sided heading score increased from 1.93 ± 1.87 to 4.27 ± 1.75, which was also statistically significant ($p < 0.001$).

In the control group (Group B), which received only conventional therapy, front-sided heading scores improved from 1.87 ± 1.13 to 3.40 ± 2.10 ($p = 0.017$), and right-sided heading scores increased from 2.00 ± 1.85 to 3.07 ± 1.75 ($p = 0.003$), both indicating significant but comparatively smaller improvements.

Overall, while both groups showed progress in heading performance following intervention, the MET group demonstrated greater gains in both front- and right-sided heading ability, suggesting that the addition of Muscle Energy Technique to conventional therapy is more effective in enhancing sport-specific performance among recreational football players.

The Table 4 presents the comparison of cervical Range of Motion (ROM) before and after intervention in both the MET and control groups. In the MET group (Group A), there was a highly significant improvement

Table 1. Comparison of age, duration of playing, and frequency of play in a week between the groups

		Mean	S.D.	"t"	*p* value
Age (Years)	MET	23.93	6.19	0.28	0.780
	Control	23.33	5.41		
Duration of playing (Years)	MET	4.57	2.33	0.60	0.555
	Control	4.08	2.19		
Frequency of play in a week (Days)	MET	3.20	0.78	-0.56	0.577
	Control	3.33	0.49		

"t" = Independent sample "t" test; MET-muscle energy technique, S.D.-standard deviation

Table 2. Comparison of NPRS within the group A = MET(n=15) and Group B = Control (n = 15)

Mean		Group A: MET				Group B: Control			
		S.D.	Mean difference	*p* value	Mean	S.D.	Mean difference	*p* value	
NPRS	Pre	5.27	1.49	2.73	< 0.001*	5.33	1.54	2.53	< 0.001*
	Post	2.53	1.25			2.80	1.61		

* Significant, MET-Muscle Energy Technique, NPRS- Numerical Pain Rating Scale, S.D.-Standard Deviation

Table 3. Comparison of heading performance within group A = MET (n=15) and Group B = Control (n=15)

Mean		Group A: MET			Group B: Control		
		S.D.	*p* value	Mean	S. D	*p* value	
Front sided heading	Pre	1.80	1.21	< 0.001*	1.87	1.13	0.017*
	Post	4.93	1.58		3.40	2.10	
Right sided heading	Pre	1.93	1.87	< 0.001*	2.00	1.85	0.003*
	Post	4.27	1.75		3.07	1.75	

* Significant, MET-muscle energy technique, S.D.-standard deviation

($p < 0.001$) in all directions of cervical movement after treatment. Cervical flexion improved from an average of 53.47° to 66.07°, and extension increased from 47.80° to 59.07°. Right lateral flexion improved from 23.47° to 38.13°, and left lateral flexion from 27.27° to 47.67°. Likewise, right-side rotation increased from 59.20° to 72.67°, and left-side rotation from 57.20° to 73.53° following MET application. In the control group (Group B), participants who received only conventional therapy also showed statistically significant improvements ($p < 0.05$) in all cervical movements, though the magnitude of improvement was smaller. Cervical flexion improved from 53.53° to 61.00°, extension from 47.87° to 54.73°, right lateral flexion from 23.53° to 32.53°, and left lateral flexion from 27.33° to 36.27°. Cervical right and left rotations improved from 59.27° to 68.60° and 57.27° to 67.80°, respectively. Overall, while both groups showed significant post-intervention gains in cervical ROM, the MET group demonstrated greater mean improvements across all movements compared to the control group.

The Table 5 shows the comparison of cervical muscle strength before and after intervention in both the MET and control groups.

In the MET group (Group A), there was a highly significant improvement ($p < 0.001$) in the strength of all cervical muscle groups after the intervention. The mean strength of the cervical flexors increased from 3.20 ± 1.01 to 4.40 ± 0.63, and extensors from 3.20 ± 1.01 to 4.60 ± 0.51. Similarly, the right and left rotator muscles showed improvements from 3.53 ± 0.83 to 4.60 ± 0.51, and from 3.47 ± 0.74 to 4.87 ± 0.35, respectively. The right and left lateral flexors also improved from 3.20 ± 0.86 to 4.53 ± 0.52, and from 3.47 ± 0.83 to 4.60 ± 0.63, respectively.

In the control group (Group B), participants who received only conventional therapy also showed significant improvements in all muscle groups, though

Table 4. Comparison of Range of Motion (ROM) within the group A: MET (n=15) and Group B= Control(n=15)

Mean		Group A: MET			Group B: Control		
		S.D.	*p* value	Mean	S.D.	*p* value	
Cervical flexion	Pre	53.47	14.37	< 0.001*	53.53	14.32	0.001*
	Post	66.07	14.30		61.00	14.97	
Cervical extension	Pre	47.80	12.14	< 0.001*	47.87	12.25	< 0.001*
	Post	59.07	14.21		54.73	11.84	
Cervical right lateral flexion	Pre	23.47	9.07	< 0.001*	23.53	9.08	< 0.001*
	Post	38.13	13.26		32.53	13.54	
Cervical left lateral flexion	Pre	27.27	11.35	< 0.001*	27.33	11.34	< 0.001*
	Post	47.67	12.55		36.27	13.49	
Cervical right-side rotation	Pre	59.20	8.55	< 0.001*	59.27	8.43	< 0.001*
	Post	72.67	12.72		68.60	12.21	
Cervical left-side rotation	Pre	57.20	10.37	< 0.001*	57.27	10.26	< 0.001*
	Post	73.53	12.87		67.80	10.67	

* Significant, MET-muscle energy technique, S.D.-standard deviation

Table 5. Comparison of cervical muscle strength within the group A: MET (n=15) and Group B= Control(n=15)

Mean		Group A: MET			Group B: Control		
		S.D.	*p* value	Mean	S.D.	*p* value	
Cervical flexors	Pre	3.20	1.01	< 0.001*	3.20	1.01	0.012*
	Post	4.40	0.63		3.87	0.83	
Cervical extensors	Pre	3.20	1.01	< 0.001*	3.20	1.01	0.007*
	Post	4.60	0.51		3.80	0.77	
Cervical right rotators	Pre	3.53	0.83	< 0.001*	3.67	0.82	0.028*
	Post	4.60	0.51		4.07	0.80	
Cervical left rotators	Pre	3.47	0.74	< 0.001*	3.47	0.74	0.003*
	Post	4.87	0.35		4.13	0.52	
Cervical right lateral flexors	Pre	3.20	0.86	< 0.001*	3.20	0.86	< 0.001*
	Post	4.53	0.52		4.00	0.76	
Cervical left lateral flexors	Pre	3.47	0.83	< 0.001*	3.47	0.83	< 0.001*
	Post	4.60	0.63		4.07	0.59	

* Significant, MET-muscle energy technique, S.D.-standard deviation

the degree of improvement was smaller compared to the MET group. Cervical flexor strength increased from 3.20 ± 1.01 to 3.87 ± 0.83 ($p = 0.012$), and extensor strength from 3.20 ± 1.01 to 3.80 ± 0.77 ($p = 0.007$). Right and left rotators improved from 3.67 ± 0.82 to 4.07 ± 0.80 ($p = 0.028$) and from 3.47 ± 0.74 to 4.13 ± 0.52 ($p = 0.003$), respectively. The right and left lateral flexors improved from 3.20 ± 0.86 to 4.00 ± 0.76 and from 3.47 ± 0.83 to 4.07 ± 0.59, both with $p < 0.001$.

Overall, both groups demonstrated statistically significant increases in cervical muscle strength after treatment. However, the improvements were greater in the MET group, indicating that the addition of Muscle Energy Technique to conventional therapy was more effective in strengthening the cervical muscles of recreational football players compared to conventional therapy alone.

5. Discussion

This study was done to compare the effectiveness of Muscle Energy Technique (MET) on cervical pain and heading performance in footballers with neck pain. The analysis

between the MET and conventional groups revealed a significant decrease in the reported post intervention pain scores. However, the improvement in MET group was more as compared to the conventional group ($p < 0.05$). A similar finding was observed in the study by Phadke *et al.*[22] where pain intensity reduced following MET over the neck area along with the other segments of the body. The reduction in pain can be attributed to MET's neurophysiological mechanisms, particularly post-isometric relaxation, which promote muscle lengthening, reduce spasm, and improve local circulation. However, there was no association found between NPRS and heading performance. Whereas NPRS showed a negative correlation ($p<0.05$) with right lateral cervical flexors.

The present study additionally focused on the effectiveness of MET on a sport-specific task-heading performance in football players which showed a significant increase in the reported post intervention heading performance (both for front side heading and right-side heading) scores. Participants who received MET showed notable improvement in heading technique, accuracy, and control by improving cervical mobility and strength. It is also seen that MET contributes in increasing the heading performance, which is consistent with literature suggesting that cervical conditioning can reduce head acceleration and improve control during impact situations, as shown by Peek *et al*[6] and Barnes-Wood *et al*[2] To further explore this relationship, a correlation between heading performance and cervical muscle strength was done which showed a positive correlation ($p<0.05$) between front side heading performance and muscle strength of cervical flexors and extensors. Similar findings were highlighted in the study by Gutierrez GM *et al*[14], whose hypothesis regarding the influence of neck strength on mitigating header impact was subsequently validated by Benji AK *et al.,*[15] Their findings emphasized the significance of cervical flexor and extensor strength in enhancing heading efficiency and control among football players.

Further analysis of intergroup outcomes revealed a statistically significant improvement in cervical Range of Motion (ROM) in both the MET and conventional groups, with the MET group demonstrating superior gains. Specifically, participants in the MET group showed significant improvements in right and left lateral flexion, whereas the conventional group exhibited greater enhancement in right and left cervical rotation. These findings are consistent with previous studies investigating the effects of MET on the cervical region, which reported similar improvements in ROM[16,17].

The mechanisms underlying the increase in ROM observed following MET intervention can be attributed to well-established physiological processes influencing muscle extensibility. These include reflex relaxation, viscoelastic changes, and enhanced stretch tolerance[18]. Reflex muscle relaxation is hypothesized to occur through activation of Golgi tendon organs, which inhibit the alpha motor neuron pool, thereby reducing muscle tension post-contraction[19-21]. Furthermore, the integration of isometric contractions followed by stretching as utilized in MET—may elicit greater viscoelastic adaptations than passive stretching alone, owing to the application of higher mechanical forces that enhance passive extensibility[22-24]. Following this, correlation analysis between the Numeric Pain Rating Scale (NPRS) and cervical ROM indicated a significant negative correlation between NPRS scores and both cervical flexion and right-side rotation. This suggests that improvements in these specific movement patterns were associated with a corresponding reduction in pain levels post-intervention.

Based on analysis there was sufficient evidence to accept the alternate hypothesis. It Significantly showed impact of MET on cervical pain and range of motion in recreational footballers.

6. Conclusion

Muscle Energy Technique is a safe and effective intervention for reducing cervical pain, enhancing range of motion, improving muscle strength, and boosting heading performance in recreational football players. Integrating MET into physiotherapy protocols may enhance both injury prevention and functional performance in football.

7. Limitations

1. The sample size was relatively small, which may limit generalizability.
2. The intervention duration was limited to four weeks, and long-term follow-up was not conducted.
3. Inter-rater and intra-rater reliability for heading performance scoring were not statistically assessed, although standardized scoring procedures were followed.

4. Cervical muscle strength was assessed using Manual Muscle Testing, which is subjective and ordinal in nature.
5. The study included a larger proportion of male participants, the results may not be directly applicable to female football players, thereby limiting the scope of gender-based generalization.

8. Future Research

Future research should focus on conducting larger multicenter Randomized Controlled Trials (RCTs) with more diverse populations to enhance the generalizability of the findings. Long-term follow-up studies are recommended to evaluate the sustainability of the benefits achieved through Muscle Energy Technique (MET). Additionally, comparative studies involving other manual therapy or exercise-based interventions could provide valuable insights into the relative effectiveness of MET in improving cervical function and performance.

9. Acknowledgements

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9.1 Data Availability Statement

The data supporting the findings of this study are openly available in fig share at https://doi.org/10.6084/m9.figshare.30373198.v1

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Author Contribution

AR: Substantially contributing to acquisition of data and drafting the article and revising; PS: Substantially contributing to conception, design, interpretation, analysis of data; AB: Substantially contributing to interpretation of data, drafting the article and revisions.

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