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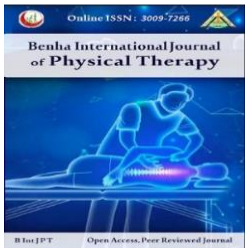

Original research

Local muscle vibration versus muscle energy technique in sacroiliac joint dysfunction

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Abstract

Background: Sacroiliac joint dysfunction (SIJD) is a significant contributor to low back and buttock pain, often challenging to diagnose and treat effectively. **Purpose**: The aim is to compare the effects of local muscle vibration (LMV) and muscle energy technique (MET) on pain, pressure pain threshold (PPT), functional disability, and innominate tilt in SIJD.**Methods**: Thirty-five patients with SIJD, aged 20-40 years, were randomized into Group A (MET; n=16) and Group B (LMV; n=19). The treatment protocol involved three sessions per week for four weeks. The variables were measured for both groups before and after the rehabilitation and at the follow-up period after 2 weeks. Pain intensity was assessed using a Visual Analog Scale (VAS), PPT was measured with a pressure algometer, self-reported pain and disability was measured using the Oswestry Disability Questionnaire for Low Back Pain (Arabic version), and innominate tilting was evaluated using the Palpation Meter (PALM).**Results:** Both interventions significantly improved pain intensity, functional disability, and pelvic alignment ($p < 0.05$), with no significant differences between groups. However, MET demonstrated superior outcomes in pelvic alignment at follow-up, especially in the sagittal plane on the left side compared to the right side ($d = 0.69$), while LMV showed superior outcomes in PPT and specific alignment measures, especially pelvic alignment in the frontal plane. **Conclusion:** Both MET and LMV are effective short-term interventions for SIJD, with MET favoring alignment outcomes and LMV demonstrating localized benefits for pain pressure thresholds. Further research is needed to explore long-term effects and optimize treatment protocols.

Keywords: Sacroiliac Joint Dysfunction; Muscle Energy Techniques; Local Muscle Vibration; Pelvic Tilt; Pain.

Introduction

Low back pain (LBP) significantly impacts quality of life and healthcare costs, affecting 49-70% of people in the US and Europe. Its prevalence increases during adolescence, with girls experiencing symptoms earlier than boys. The incidence peaks between the ages of 40 and 69, with females being more affected than males. Sacroiliac joint dysfunction (SIJD) accounts for approximately 13% of LBP cases[1]. About 44% of SIJD cases result from physical trauma. Activities such as heavy lifting, bending, and prolonged sitting or standing can exacerbate SIJD-related pain[2,3]. Diagnosing SIJD primarily relies on physical examinations and patient history. However, treatment outcomes remain limited, highlighting the need for further research to

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compare therapeutic approaches[4]. No previous study has directly compared Local Muscle Vibration (LMV) and Muscle Energy Technique (MET) for managing sacroiliac joint dysfunction (SIJD), making this research significant in filling this gap and providing clinically relevant insights.

Manual therapy techniques for treating SIJD, including Muscle Energy Technique (MET), myofascial release, Strain Counter Strain (SCS), manipulation, and craniosacral therapy, aim to reduce pain, improve joint mobility, and restore function by targeting the musculoskeletal and fascial structures surrounding the sacroiliac joint[5].

The primary goal of MET is to restore flexibility in tight muscles, thereby improving joint mobility and function. Additionally, MET can enhance muscular strength, increase the range of motion, and reduce swelling. Research has demonstrated that MET provides significant relief for individuals with chronic SIJD, alleviating pain and reducing anterior pelvic tilt[4]. Vaseghnia et al, also examined the therapeutic effects of MET on SIJD in young women, suggesting that MET may be more effective in alleviating symptoms in this population[6].

Vibration therapy (VT) has been proposed to enhance physical performance and counteract the effects of aging on muscles, tendons, and bones. However, the application techniques, frequency, and intensity of VT vary considerably[7]. Local muscle vibration, in particular, involves the use of rapid, sustained vertical strokes to stimulate neuromuscular junctions, which can improve the range of motion and reduce muscle pain.[8] Numerous studies have confirmed that Muscle Energy Technique (MET) has a positive impact on cases of Sacroiliac Joint Dysfunction (SIJD)[4,2,9,10,6] A narrative literature review includes approximately 35 studies examining the impact of local vibration therapy on different performance parameters. It highlights that LMV positively influences muscle activation, strength, power, and joint range of motion [11] .To the author's knowledge, no previous studies have investigated the comparative effects of LMV and MET in managing SIJD. Consequently, This research primarily aims to evaluate the effects of local muscle vibration compared to the Muscle Energy Technique on pain intensity, pain pressure threshold, functional disability, and innominate angle tilt in individuals with sacroiliac joint dysfunction (SIJD).

Methods

Study Design

This was a double-blind study, Participants were blinded to the treatment they received to minimize bias in self-reported outcomes, such as pain intensity and functional disability. Additionally, the Statistician was blinded. Comparative clinical trial evaluated the effects of Muscle Energy Techniques and Local Muscle Vibration. The study involved a four-week intervention (three sessions per week) with a two-week follow-up. Outcomes, including pain intensity, functional disability, pain pressure threshold, and innominate angle tilt were measured and analyzed using SPSS with parametric tests applied where appropriate.

Participants:

The study conducted between June 2023 and October 2024 at Dessouk General Hospital, included 35 patients aged 20-40 years with SIJD. Participants were randomly assigned to either the MET group (Group A) or the LMV group (Group B).

Patients aged 20 to 40 years referred by the orthopedic surgeon with a diagnosis of sacroiliac joint dysfunction (SIJD) were included in the study. Eligibility criteria required a pain intensity score greater than 3 on the Visual Analog Scale (VAS), with pain localized around the posterior superior iliac spine and sacral sulcus. Additionally, participants needed to exhibit at least three positive results from six validated provocation tests (Compression, Gaenslen, posterior friction, sacral thrust, and FABER test) (12),(13). Exclusion criteria included patients with neurological issues, sacroiliitis, or spondylolisthesis. Individuals who were pregnant, diagnosed with rheumatoid arthritis, or had a history of significant surgeries involving the lower limbs or spine were also excluded from the study.

Procedures:

Baseline assessments included evaluations of pain intensity using the Visual Analog Scale (VAS), pain pressure threshold (PPT) assessed with a pressure algometer (Manual type, Mechanical push-pull dynamometer),[14] and functional disability measured by the Arabic version of Oswestry Disability Index (ODI).[15] Additionally, the innominate angle tilt was

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assessed using the Palpation Meter Device (PALM, U.S. Patent 5327907)[16,10].

Following baseline measurements, participants received treatments three times weekly for four weeks. A reassessment was conducted directly after four weeks of intervention and after two weeks post-intervention for follow-up.

Group A: Muscle Energy Techniques (MET) MET targeted the quadratus Lumborum, erector spinae, Iliacus, and piriformis muscles. The protocol involved Isometric contraction in which Patients performed a contraction at ~30% effort against the therapist's resistance for 7-10 seconds. A 5-second relaxation phase followed by a stretch to the new range barrier, held for 10-60 seconds. Each stretch was repeated 3-5 in each session.

Specific techniques included:

Quadratus Lumborum: Patients positioned side-lying; the therapist provided resistance over the pelvis during pelvis elevation and performed a stretch by pulling the pelvis away from the ribs (Fig. 1). **Erector spinae**: Patients seated with hands clasped behind the neck; the therapist guided flexion, side-bending, and rotation to engage the muscle (Fig. 2A & 2B). **Iliacus**: The patient supine with one leg hanging off the treatment table while the therapist applied counterpressure at the thigh to stretch the Iliacus (Fig. 3). **Piriformis**: The patient supine with the treated leg crossed over the opposite knee; the therapist stabilized the pelvis and guided the leg into resisted abduction, followed by further stretching into adduction (Fig. 4

Figure 1: MET for Quadratus Lumborum

Figure 2: (A&B) MET for Erector Spinae muscle. Frontal view (A), Transverse view (B).

Figure 3: MET For Iliacus Muscle.

Figure 4 MET for Piriform muscle.

Group B: Local Muscle Vibration

Local Muscle Vibration involves a handheld vibration device (The PHOENIX (Gun Vibrator) device operates at a frequency of 50/60 Hz and features three-speed levels (1, 2, 3)), set to 30-50 Hz, we applied the lower speed level (1), with a soft attachment head (Fig. 5), targeting the same muscles treated in MET. The therapist applied the device to the most painful points and along the muscle fiber direction for 2 minutes at each muscle.

Figure 5 The handheld vibration gun device, with interchangeable attachment heads. The soft attachment head will be utilized in this study (1), Hard plain. (2), spinal (3), hard ball (4), and trigger point head (5).

Specific techniques included:

Quadratus Lumborum: Patients prone; the device applied from the iliac crest to the lateral lumbar region (Fig. 6). **Erector spinae:** Patients prone; the device applied along the paravertebral muscles, with scapular stabilization (Fig. 7). **Iliacus:** Patient supine; the therapist palpated the Iliacus and applied the device to deep muscle fibers (Fig. 8A& B). **Piriformis:** Patient side-lying; the therapist applied vibration along the piriformis, located between the posterior superior iliac spine and the greater trochanter (Fig. 9).

Figure 6: Local Muscle Vibration for Quadratus Lumborum.

Figure 7: Local Muscle Vibration for Erector Spinae.

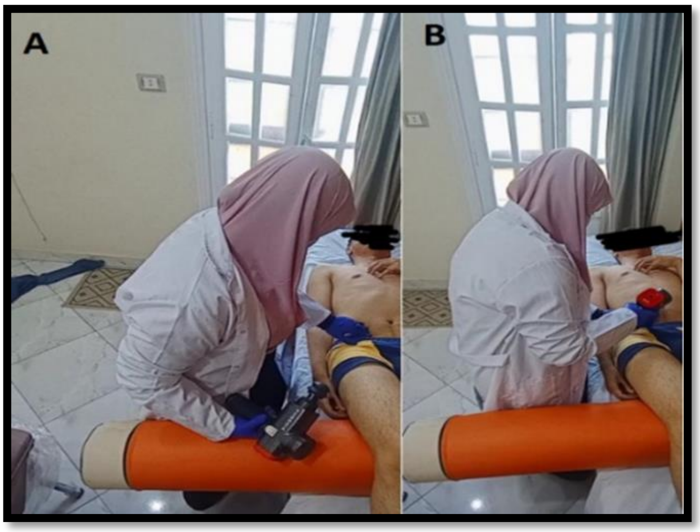

Figure 8: (A) Iliacus muscle palpation, (B) Local Muscle Vibration for Iliacus.

Figure 9: Local Muscle Vibration for Piriformis.

Both groups followed identical session schedules, with standardized protocols ensuring consistency throughout the study.

Statistical analysis:

Data were analyzed using IBM SPSS Statistics 26 (IBM Corp, Armonk, NY, USA). Descriptive statistics were presented as mean ± standard deviation for quantitative variables and percentages for qualitative variables. The Shapiro-Wilk test assessed the normality of outcome distributions. Multivariate Analysis of Variance (MANOVA) evaluated the effects of the two rehabilitation protocols on pain intensity, pain pressure threshold, functional disability, and innominate angle tilt.Statistical significance was set at p < 0.05.

Results

Subject characteristics:

There were no significant differences between the groups in sex distribution (*p* = 0.865), age (*p* = 0.139), or BMI (p = 0.669) (Table 1).

Table 1: Descriptive statistics for demographic variables.

Variables	Group A N = 16	Group B N = 19	t-value	*P*-value	Sig.
	Mean ± SD	Mean ± SD			
Age (years)	32.88 ± 6.975	29.42 ± 6.492	1.516	0.139	NS
Weight (Kg)	28.294 ± 3.757	27.684 ± 4.474	0.431	0.669	NS
Sex distribution	**Count (%)**	**Count (%)**	**χ^2 value**	**p-value**	**Sig**
Females	13 (81.25 %)	15 (78.95 %)	0.029	0.865	NS
Males	3 (18.75 %)	4 (21.05 %)			

Multivariate analysis of variance (MANOVA) was used to assess the effects of both rehabilitation programs on pain intensity, functional disability, PPT (right and left sides), and innominate bone alignment. A significant interaction effect of rehabilitation and time was observed for all dependent variables (*p* < 0.001), except for PALM Sagittal LT (*p* = 0.402). Significant interaction effects were noted for most variables (*p* < 0.05), except for PALM Sagittal RT (*p* = 0.491) and PALM Sagittal LT (*p* = 0.722) (Table 2).

Table 2: Effect of timing of rehabilitation on all dependent variables in both groups.

Repeated measure MANOVA		
Interaction effect (Group * time)		
VAS	F = 0.635	*p* = 0.536
ODI	F = 0.40	*p = 0.961*
PPTRT	F = 7.639	*p = 0.002**
PPTLT	F = 3.577	*p* = 0.040*
PALM Frontal	F = 3.682	*p* = 0.036*
PALM Sagittal RT	F = 0.727	*p* = 0.491
PALM Sagittal LT	F = 0.329	*p* = 0.722
Effect of time		
VAS	F = 14.901	*p* < 0.001*
ODI	F = 45.368	*p < 0.001**
PPTRT	F = 33.292	*p < 0.001**
PPTLT	F = 15.281	*p* < 0.001*
PALM Frontal	F = 8.600	*p* = 0.001*
PALM Sagittal RT	F = 10.931	*p* < 0.001*
PALM Sagittal LT	F = 0.937	*p* = 0.402

Pain intensity:

Pain intensity, measured using the VAS, significantly decreased post-rehabilitation and at follow-up compared to pre-rehabilitation ($p < 0.001$). However, no significant difference was observed between the follow-up and post-rehabilitation measures ($p = 0.254$). No significant differences were found between groups across the three measurement intervals (Table 3).

Functional disability:

Functional disability assessed using the ODI significantly decreased post-rehabilitation and at follow-up compared to pre-rehabilitation ($p < 0.001$). ODI also decreased at follow-up compared to post-rehabilitation ($p = 0.016$). No significant differences were found between the groups across the three measurement intervals (Table 3).

Pressure pain threshold (PPT)

PPT significantly increased on both sides post-rehabilitation and at follow-up compared to pre-rehabilitation ($p < 0.001$ for the right side; $p = 0.005$ for the left side). However, PPT decreased at follow-up compared to post-rehabilitation ($p < 0.001$). No significant differences were found between the groups for the three intervals, except for the post-rehabilitation measure on the left side ($p = 0.035$) (Table 3).

PALM Frontal:

PALM Frontal measurements significantly decreased post-rehabilitation and at follow-up compared to pre-rehabilitation ($p = 0.011$, $p < 0.001$). No significant difference was observed between follow-up and post-rehabilitation ($p = 0.120$). Similarly, no significant differences were found between the groups across the three intervals (Table 3).

PALM Sagittal:

PALM Sagittal measurements, the right side significantly decreased post-rehabilitation and at follow-up compared to pre-rehabilitation ($p < 0.001$, $p = 0.002$). However, no significant differences were found for the left side or between follow-up and post-rehabilitation ($p = 0.069$, $p = 0.455$). Between-group differences were not significant, except for the follow-up measure on the left side ($p = 0.048$) (Table 3).

Table 3: Mean clinical outcomes and MANOVA testing between groups A and B.

	Pre rehabilitation	**Post rehabilitation**	**Follow up**	**Pairwise comparison**		
	mean ± SD	**mean ± SD**	**mean ± SD**	**Pre-rehabilitation vs. post-rehabilitation**	**Pre-rehabilitation vs. follow up**	**Post-rehabilitation vs. follow-up**
VAS (cm)						
Group A	5.913±1.386	5.150 ±0.968	5.294±1.55	<0.001*	<0.001*	0.254
Group B	5.611±1.452	4.474±1.162	4.647±1.15	<0.001*	<0.001*	0.254
p-value	*p* = 0.536	*p* = 0.073	*p* = 0.167			
ODI (%)						
Group A	33.5±8.718	29.00±8.824	29.75±9.349	<0.001*	<0.001*	0.016*
Group B	32.74±6.332	28.42±6.274	29.26±6.607	<0.001*	<0.001*	0.016*
p-value	*p* = 0.766	*p* = 0.822	*p* = 0.585			
PPT RT (Kg)						
Group A	3.26±0.662	3.44±0.666	3.34±0.691	<0.001*	0.005*	<0.001*
Group B	3.32±0.620	3.88±0.604	3.63±0.695	<0.001*	0.005*	<0.001*
p-value	*p* = 0.777	*p* = 0.051	*p* = 0.221			
PPT LT (Kg)						
Group A	3.36±0.514	3.54±0.556	3.45±0.546	<0.001*	<0.001*	0.001*

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Group B	3.39±0.530	3.94±0.515	3.75±0.573	<0.001*	<0.001*	0.001*
p-value	*p* = 0.872	*p* = 0.035*	*p* = 0.125			
PALM Frontal (degrees)						
Group A	1.75±0.577	1.25±0.447	1.19±0.403	0.011*	<0.001*	0.120
Group B	1.58±0.507	1.58±0.507	1.42±0.507	0.011*	<0.001*	0.120
p-value	*p* = 0.358	*p* = 0.052	*p* = 0.146			
PALM Sagittal Rt (degrees)						
Group A	10.56±1.999	10±1.549	10.06±1.526	<0.001*	0.002*	0.069
Group B	9.42±2.194	8.84±1.951	9.11±1.853	<0.001*	0.002*	0.069
p-value	*p* = 0.120	*p* = 0.064	*p* = 0.109			
PALM Sagittal Lt (degrees)						
Group A	10.19±1.905	10±1.897	10±1.862	0.363	0.175	0.455
Group B	9±1.944	8.95±1.508	8.79±1.619			
p-value	*p* = 0.078	*p* = 0.076	*p* = 0.048*			

Group A (MET), Group B (LMV)

Discussion

Conservative interventions for managing Sacroiliac Joint Dysfunction (SIJD) include physical therapy, chiropractic adjustments, and pharmacological treatments, with a focus on manual therapy techniques. These techniques, such as Muscle Energy Technique (MET), Strain-Counterstrain (SCS), myofascial release, craniosacral therapy, and manipulation, aim to restore normal joint dynamics, reduce pain, and improve mobility[5]. MET specifically targets muscle flexibility by lengthening tight or shortened muscles, enhancing joint mobility, and improving strength and range of motion[4] "This study compared the effects of MET and Local Muscle Vibration (LMV) on SIJD, providing valuable insights into their relative efficacy ".

The findings demonstrated that both MET and LMV significantly reduced pain intensity, and functional disability, and improved pressure pain threshold (PPT) and innominate tilt. However, MET exhibited faster pain relief, greater mobility improvements, and more sustained benefits, consistent with prior studies suggesting MET's superiority in managing musculoskeletal dysfunctions[4,2,9,10,6]. For instance, MET's ability to target specific muscles like the iliopsoas and hamstrings promotes relaxation and muscle balance, making it an effective low-cost intervention for chronic SIJD[4,17].

These results align with existing evidence that MET demonstrates superior performance to passive stretching in reducing piriformis tightness and enhancing the range of motion, as reported in studies on chronic low back pain[18,17].

The findings also indicate that LMV can serve as a beneficial adjunctive therapy. Local Muscle Vibration, mainly a soft tissue manipulation therapy, uses vertical strokes to stimulate neuromuscular junctions, reduce muscle pain, and increase flexibility, helping to improve overall function and alleviate discomfort[19,5,4,8] .

The study by Dueñas et al found that vibration treatment (VT) increased the total pressure pain threshold (PPT) in the vibration group (VG) compared to the control group (CG), suggesting that VT may aid in pain relief and tissue repair through mechanotransduction mechanisms[20] ,The study by Ishikura (2024) found that local vibration stimulation improved muscle luminosity, indicating better blood flow and nutrient delivery, but had no significant effect on muscle strength, hardness, or thickness. While promising for muscle recovery, its impact on performance and hypertrophy is limited[21] .Felici et al. (2012) found that local mechanical vibration (LV) increases oxygenated hemoglobin in treated muscles, improving blood flow, vasodilation, and muscle oxygenation without causing systemic effects. LV shows potential as a therapeutic tool in clinical and rehabilitation settings[22].

The investigations on local mechanical vibration (LMV) found that muscular activation was the most commonly assessed outcome, followed by muscular strength and power. Flexibility and joint range of motion were also evaluated. [11] Most studies showed positive effects on muscle performance, flexibility, and reduced joint dysfunction. Frequencies between 30 to 50 Hz, which align with motor unit discharge rates during maximal exertion, were effective in promoting therapeutic benefits like improved isometric muscle strength[23,24].

Interestingly, this study found no significant differences between the interventions for certain measures, such as sagittal innominate tilt (PALM Sagittal). This result warrants further investigation to identify whether specific patient characteristics, such as baseline pelvic asymmetry or muscle imbalances, influence outcomes.

Clinically, MET offers a practical and cost-effective solution, particularly for patients seeking hands-on therapeutic approaches. LMV, while requiring specialized equipment, could be a viable alternative for patients who cannot tolerate manual techniques or require localized stimulation. Future studies could explore combining these modalities to maximize patient outcomes.

Limitations

This study has several limitations that should be considered. The high rate of dropout of cases is due to difficulties in participant allocation, long periods of the treatment program, and cases that prefer a complete treatment program to be satisfied and complete the program till follow-up. So, the final small sample size (n = 35) may limit the generalizability of the findings, reducing the statistical power to detect subtle differences between the groups. To demonstrate the development of this clinical study, a flow diagram based on the Consolidated Standards of Reporting Trial (CONSORT) statement was presented (Fig. 10).

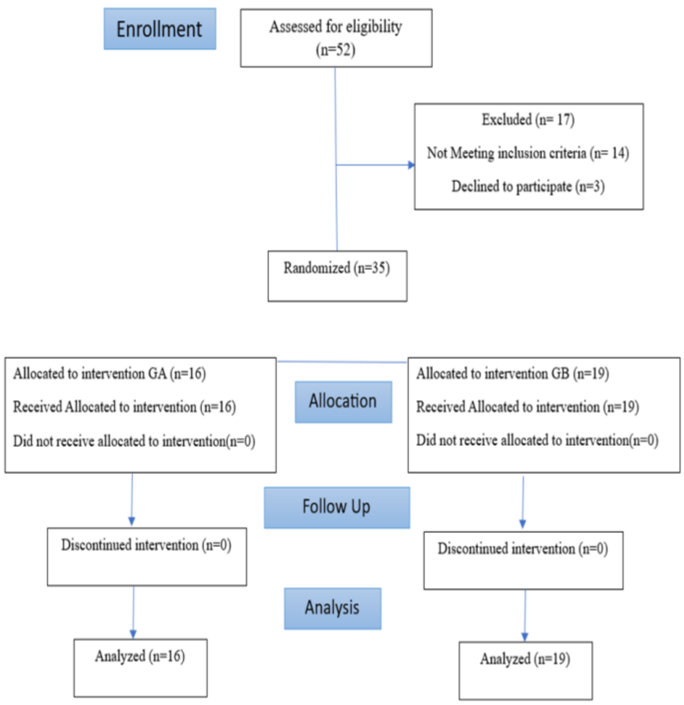

Figure 10: CONSORT Flow Diagram of Participant Enrollment and Analysis

The two-week follow-up period was insufficient to assess long-term outcomes, such as symptom recurrence or sustained functional improvements. Additionally, the study's single-intervention design (MET or LMV) excluded combined or multimodal approaches, which could potentially yield superior outcomes.

Using one technique also resulted in some patients not participating or completing the program. Patient adherence and psychological factors may have influenced the results. Although standardized protocols were followed, variability in patient effort during interventions might have affected outcomes like PPT and functional disability.

Lastly, the study was conducted in a single clinical setting, which may limit its external validity. Future research should replicate this study in diverse clinical environments and incorporate additional variables, such as cost-effectiveness and patient satisfaction, to further refine therapeutic guidelines for SIJD management.

Conclusion

Both interventions were effective in reducing pain intensity, improving functional disability, and enhancing pelvic alignment. MET showed greater efficacy in improving pelvic alignment at follow-up, especially in the sagittal plane LT side than the RT side, while LMV was particularly beneficial in increasing pain pressure threshold and contributing to specific alignment improvements, especially pelvic alignment in the frontal plane. These findings suggest that MET may be preferable for patients prioritizing long-term alignment outcomes, while LMV offers advantages in addressing localized pain thresholds.

Although both techniques proved effective, the high rate of dropout of cases and short follow-up period limit the generalizability of the results. Future studies with larger cohorts and extended follow-up durations are needed to confirm these findings and explore their long-term clinical implications.

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Ethical approval

The study was conducted following ethical standards for the operation of the devices used and received approval from the Faculty of Physical Therapy at Cairo University's Ethical and Protocol Review Committee (012/004696). This trial is registered with ClinicalTrials.gov under ID NCT06227637.

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