

MUSCLE ENERGY TECHNIQUE(MET) COMBINED WITH KINESIO TAPING FOR FUNCTIONAL RECOVERY IN PATIENTS WITH ANKLE SPRAIN: A RANDOMIZED CONTROLLED TRIAL

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Abstract: Objective: To evaluate the effects of muscle strength training combined with kinesio taping on pain, swelling, and functional recovery in patients with acute ankle sprain. Methods: Forty patients with acute ankle sprain were randomly assigned to either a control group (muscle strength training alone, n=20) or an experimental group (muscle strength training combined with kinesio taping, n=20). Both interventions were administered once every other day for two weeks. Visual Analog Scale (VAS) for pain, swelling degree (affected limb circumference), and AOFAS ankle-hindfoot function score were assessed before treatment and at days 1, 5, 9, and 14 post-treatment. Results: The experimental group demonstrated significantly lower VAS scores and significantly smaller affected limb circumference compared with the control group at all post-treatment time points (all $p < 0.001$). The AOFAS total score was significantly higher in the experimental group than in the control group (96.25 ± 5.59 vs. 74.95 ± 10.86 , $p < 0.001$), with significant advantages in pain, daily activities, walking surface, foot alignment, gait, and range of motion subscales ($p < 0.05$ or $p < 0.001$). Conclusion: Muscle strength training combined with kinesio taping significantly alleviates pain, reduces swelling, and improves functional recovery in patients with acute ankle sprain, offering a more effective rehabilitation strategy than muscle strength training alone.

Keywords: Ankle sprain; Kinesio taping; Muscle strength training

1 INTRODUCTION

Ankle sprain typically refers to injuries to the soft tissues surrounding the joint, such as ligaments and joint capsules, caused by joint movement exceeding the normal range. It is often accompanied by joint swelling, pain, and restricted mobility, and most commonly occurs on the lateral side of the ankle. Studies have found that in sports involving directional changes and jumping, the incidence of lateral ankle sprains is 76.7% [1]. A large number of ankle sprains occur each year, and most patients with acute ankle injuries can return to their pre-injury level of sports activity within one year. However, such injuries not only affect an individual's daily living ability but may also evolve into chronic ankle instability if early treatment is inadequate or if high-intensity physical activity is resumed prematurely without systematic rehabilitation training [2]. In severe cases, this may lead to long-term dysfunction and chronic pain [3]. Currently, the treatment of ankle sprains has developed into a comprehensive system covering acute phase management (POLICE principles), conventional medical interventions (bracing/physical therapy), systematic rehabilitation (strength/balance/range of motion training), and surgical intervention when necessary [4-5]. Among these, rehabilitation is central to restoring function and preventing recurrence. Kinesio taping, as an emerging rehabilitation adjunct, has demonstrated potential in improving joint range of motion, reducing swelling, alleviating pain, enhancing proprioception, and increasing muscle strength due to its unique biomechanical properties (e.g., good extensibility, breathability). It is often used as a supplement to traditional rehabilitation. However, existing studies primarily focus on combining kinesio taping with conventional management or physical therapy, and there is limited literature on its integration with systematic Muscle Energy Technique (MET). Therefore, this study aims to investigate the therapeutic effects of a combined intervention of MET and kinesio taping in patients with ankle sprain, in order to provide new evidence-based evidence for clinical rehabilitation.

2 RESEARCH METHODS

2.1 Study Subjects

This study primarily focused on individuals with acute ankle sprain. All participants were recruited from patients attending the 88th Hospital of Tai'an between June 2024 and June 2025. A total of 40 patients meeting the inclusion criteria were enrolled and randomly divided into two groups using random sampling.

Diagnostic Criteria for Acute Ankle Sprain

According to the Criteria of Diagnosis and Therapeutic Effect of Traditional Chinese Medicine Diseases (promulgated by the State Administration of Traditional Chinese Medicine of the People's Republic of China), the diagnostic criteria for ankle sprain are: 1) A definite history of ankle injury; 2) Presence of ankle pain, local swelling, joint deformity, subcutaneous ecchymosis, and restricted joint movement; 3) Significant tenderness upon ankle inversion; for inversion sprain, severe pain in the anteroinferior aspect of the lateral malleolus; for eversion sprain, pain in the anterior and

inferior part of the medial malleolus during eversion movement; 4) Fracture, dislocation, or grade III ligament injury ruled out by X-ray and other relevant auxiliary examinations.

Inclusion Criteria

1) Meeting the above diagnostic criteria; 2) Aged 15–45 years; 3) Grade I or II ankle sprain; 4) Sprain occurring within 48 hours; 5) No other treatments received after injury; 6) No skin breakage at the injury site and no history of skin diseases such as contact dermatitis; 7) Understanding of the experimental content and voluntary provision of signed informed consent.

Exclusion Criteria

1) Failure to meet the inclusion criteria; 2) Open sprain or severe injury to tendons, nerves, or blood vessels at the closed sprain site requiring surgical treatment; 3) Mental disorders hindering communication; 4) Pregnancy or breastfeeding; 5) Allergy to kinesio taping.

2.2 Experimental Methods

2.2.1 Intervention methods

The experimental group received a combined intervention of "Muscle Energy Technique (MET) + Kinesio Taping", while the control group received MET alone. Both groups adhered to the POLICE principle. The experimental group received kinesio taping once every other day for two weeks. Both groups received cold compresses within 24 hours post-treatment (3-5 times daily, 20 minutes each, with 2-hour intervals) combined with limb elevation. Functional training began 48 hours post-injury. VAS, swelling degree, and Takakura ankle function scores were measured before treatment and on days 1, 5, 9, and 14 post-treatment. SPSS was used for data analysis.

① Muscle Energy Technique (MET)

MET was conducted in three progressive phases, with advancement permitted only when current exercises could be performed easily and painlessly.

Phase I: Basic Training

Exercises included towel/marble curling with toes, ankle pumps, isometric contractions in multiple directions (5-10 second holds), and elastic band resistance training for dorsiflexion, plantar flexion, inversion, and eversion (eversion emphasized).

Phase II: Functional Strength Enhancement

Exercises included heel raises (bilateral to unilateral; level ground to step edge, emphasizing eccentric control), mini-squats/single-leg mini-squats (30° flexion, knee aligned with toes), forward-backward lunges, and step-down training for eccentric control and stability.

Phase III: Dynamic Integration and Neuromuscular Control

Exercises included progressive balance training (single-leg standing on stable to unstable surfaces, eyes open to closed, with ball toss), star excursion balance training (eight directions), stepping training (forward/backward/lateral), and plyometric training (vertical jumps to unilateral hops to box jumps, emphasizing proper landing mechanics).

General parameters: 2-4 sets of 10-15 repetitions or 30-60 second holds, 2-3 times weekly. Sharp pain warranted cessation; mild muscle soreness was normal but joint pain/swelling indicated overload. Movement quality was prioritized over speed or load.

② Kinesio Taping Application

A three-layer progressive taping method was applied and remained in place for 24 hours.

Layer 1 (Base Layer): Continuous Decompression and Drainage – "Modified Fan Cut"

A 4-6 strip fan-cut was applied with the anchor on the non-edematous distal dorsum. Strips were applied with 10-15% tension, fanning over edema-prone areas and extending upward to the lower leg.

Layer 2 (Middle Layer): Neuromuscular Activation and Sensory Input – "Y-shaped"

Anchor was placed without tension below the fibular head. With resisted foot eversion, two tails were applied with 15-25% tension along the peroneal muscles to the lateral foot border.

Layer 3 (Upper Layer): Dynamic Mechanical Stability

Two techniques were used: "Woven Basket" (two I-strips crossing to form a woven configuration around the ankle) or "Enhanced Locking" (one I-strip from medial arch across the plantar aspect, wrapping the heel to the anterolateral lower leg). These provided strong mechanical support and heel stabilization.

2.2.2 Outcome measures

Outcome measures included the Visual Analog Scale (VAS), Swelling Degree Assessment, and the AOFAS Ankle-Hindfoot Function Score.

3 RESULT

Table 1 Demographic Characteristics of Study Participants

Group	n	Gender		Age (years)
		Male	Female	
Control group	20	20	0	26.1±4.51
Experimental group	20	20	0	24.85±3.45

	$\chi^2=0$	F=0.499
<i>P</i>	1	0.331

As shown in Table 1, there were no significant differences in gender or age between the two groups, indicating successful randomization and good comparability between groups. This facilitates the interpretation of subsequent functional recovery outcomes and reduces potential confounding of intervention effects by demographic variables.

Table 2 VAS Scale

	Control group	Experimental group	F	t	<i>P</i>
Pre-treatment	7.5 ± 0.51	7.5 ± 0.51	1	0	1
Day 1	6.5 ± 0.51	5.1 ± 0.72	0.51	7.094	<0.001
Day 5	4.25 ± 0.64	2.35 ± 0.49	1.703	10.561	<0.001
Day 9	2.5 ± 0.51	0.6 ± 0.5	1.042	11.831	<0.001
Day 14	1.35 ± 0.49	0.15 ± 0.37	1.784	8.779	<0.001
t	36.910	44.112			
<i>P</i>	<0.001	<0.001			

As shown in Table 2, from Day 1 to Day 14 post-treatment, the VAS scores of the experimental group (muscle strength training combined with kinesio taping) were significantly lower than those of the control group (muscle strength training alone), with highly statistically significant differences between the two groups at all time points (all $p < 0.001$). VAS scores in both groups decreased significantly after treatment compared with baseline (control group: $t = 36.910$, $p < 0.001$; experimental group: $t = 44.112$, $p < 0.001$), indicating that both interventions were effective in alleviating pain. The experimental group demonstrated markedly faster and greater pain relief than the control group. By Day 14 post-treatment, the pain score in the experimental group had dropped to near pain-free levels (0.15 ± 0.37), whereas the control group still presented with mild pain (1.35 ± 0.49).

Table 3 Swelling Score

	Control group	Experimental group	F	t	<i>P</i>
Pre-treatment	26.76 ± 0.44	26.68 ± 0.43	1.014	0.617	0.541
Day 1	25.96 ± 0.44	24.78 ± 0.28	2.442	10.129	<0.001
Day 5	24.18 ± 0.38	23.04 ± 0.32	1.365	10.204	<0.001
Day 9	23.27 ± 0.38	22.63 ± 0.33	1.341	5.751	<0.001
Day 14	22.82 ± 0.34	22.43 ± 0.32	1.099	3.762	<0.001
t	143.560	118.317			
<i>P</i>	<0.001	<0.001			

As shown in Table 3, from Day 1 to Day 14 post-treatment, the affected limb circumference in the experimental group (combined intervention) was significantly smaller than that in the control group (single intervention), with highly statistically significant differences between the two groups at all time points (all $p < 0.001$). Affected limb circumference decreased significantly in both groups after treatment compared with baseline (control group: $t = 143.560$, $p < 0.001$; experimental group: $t = 118.317$, $p < 0.001$), indicating that both interventions were effective in promoting swelling resolution. The experimental group demonstrated notably faster and greater swelling reduction, particularly in the early phase (Days 1 and 5 post-treatment). By Day 14 post-treatment, swelling continued to improve in both groups, yet the experimental group maintained a significant advantage.

Table 4 AOFAS Score

Variable	Control group	Experimental group	F	t	<i>P</i>
Age	26.1 ± 4.51	24.85 ± 3.45	0.499	0.985	0.331
Pain	26 ± 5.03	37 ± 4.7	1.583	-7.148	<0.001
Function and daily activities	7.6 ± 1.23	10 ± 0	33.778	-8.718	<0.001
Maximum walking distance	4.85 ± 0.37	5 ± 0	19.776	-1.831	0.083
Walking surface	3.4 ± 0.82	5 ± 0	33.778	-8.718	<0.001
Gait abnormality	7.2 ± 1.64	8 ± 0	33.778	-2.179	0.042
Anterior-posterior motion	6.8 ± 1.88	8 ± 0	99.750	-2.854	0.01
Hindfoot motion	5.1 ± 1.41	6 ± 0	99.750	-2.854	0.01
Ankle-hindfoot stability	8 ± 0	8 ± 0	-	-	1

Foot alignment	6 ± 2.05	9.25 ± 1.83	0.669	-5.284	<0.001
Total score	74.95 ± 10.86	96.25 ± 5.59	15.692	-7.799	<0.001

As shown in Table 4, in terms of overall function, the total functional score of the experimental group (96.25 ± 5.59) was significantly higher than that of the control group (74.95 ± 10.86), with a highly statistically significant difference ($t = -7.799$, $p < 0.001$). The total score of the experimental group was close to full marks, indicating that their functional recovery approached normal levels. Regarding the individual functional dimensions, the experimental group scored significantly higher than the control group on four key subscales—"Pain," "Function and Daily Activities," "Walking Surface," and "Foot Alignment"—with extremely pronounced advantages (all $p < 0.001$). In terms of mobility and gait, the experimental group also demonstrated significant superiority on "Gait Abnormality," "Anterior-Posterior Motion," and "Hindfoot Motion" ($p < 0.05$). No statistically significant differences were observed between the two groups on "Maximum Walking Distance" or "Ankle-Hindfoot Stability" ($p > 0.05$), indicating that both groups achieved comparable outcomes on these two specific functional items.

4 DISCUSSION

This study comprehensively evaluated the effects of muscle strength training combined with kinesiо taping on pain, swelling, and ankle function in patients with ankle sprain. The results confirmed that the combined intervention was significantly superior to muscle strength training alone across all three core outcome measures, with the advantages persisting from the early treatment phase through to the study endpoint. In terms of pain control, the VAS scores of the combined intervention group were significantly lower than those of the control group from Day 1 post-treatment through Day 14 ($p < 0.001$). This finding is consistent with previous research [6], which reported that the combination of Shangke Zhiyang Plaster and kinesiо taping resulted in significantly greater improvement in VAS scores compared with taping alone two weeks after ankle sprain treatment. The analgesic effect of kinesiо taping may be attributed to its elastic recoil properties, which elevate the space between skin and subcutaneous tissue, thereby improving local blood circulation and clearance of inflammatory mediators [7]. Regarding swelling reduction, the combined intervention group demonstrated a significant advantage in reducing limb circumference as early as Day 1 post-treatment ($p < 0.001$), and this advantage was sustained throughout the observation period. Through the fan-shaped tension zone of the "fan cut" application, kinesiо taping can effectively direct interstitial fluid toward lymphatic drainage pathways, thereby accelerating swelling resolution [8]. The present findings provide new empirical evidence supporting the efficacy of combined intervention in acute-phase swelling management. In terms of ankle functional recovery, the total functional score of the combined intervention group (96.25±5.59) was significantly higher than that of the control group (74.95±10.86) ($p < 0.001$), with pronounced advantages observed in key subdomains including pain, walking surface, and foot alignment. Kinesiо taping may enhance ankle proprioceptive input through stimulation of cutaneous mechanoreceptors, thereby improving neuromuscular control and dynamic postural stability [9]. Recent studies have also confirmed that kinesiо taping intervention significantly improves postural control, dynamic balance, and instability sensation in individuals with chronic ankle instability [10]. The present study extends this mechanism to the early rehabilitation phase of acute ankle sprain, suggesting that the combined intervention not only achieves symptom control but also translates these improvements into comprehensive enhancement of functional activity capacity.

5 CONCLUSION

The combined application of kinesiо taping on the basis of standard muscle strength training significantly improves comprehensive functional scores in patients with ankle sprain. This combined intervention represents an effective rehabilitation strategy that simultaneously optimizes symptom management (pain, swelling) and functional outcomes (range of motion, walking ability, overall function).

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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