

ORIGINAL ARTICLE

## Effects of Neuromuscular Training with and Without Kinesio-Tape on Pain, Range of Motion, Balance and Function in Footballer with Ankle Sprain

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### ABSTRACT

**OBJECTIVE:** To determine the effects of neuromuscular training with and without kinesio-tape on pain, range of motion, balance, and function in footballers with ankle sprain.

**METHODOLOGY:** The randomized control trial was conducted at the Pakistan Sports Board, Lahore, from March to August 2023. The Squeeze and Talar Tilt Test purposefully identified thirty male football players who sustained grade I and II ankle sprains. Assigned to group A randomly, neuromuscular training alone (control n=15) and group B neuromuscular training with kinesio-tape (experimental n=15). Both groups performed neuromuscular training for 15–20 min for 4 weeks (three times per week), and after each session, Kinesio-tape was applied to the experimental group. Pain Intensity was evaluated with the Numerical pain rating scale (NPRS), range of motion (ROM) was measured by goniometer, dynamic balance status was assessed with the Star excursion balance test (SEBT), and ankle function was assessed with functional ankle ability measure (FAAM-Sports Subscale).

**RESULTS:** After 4 weeks of intervention, both groups significantly improved all outcome measures. However, there was significant improvement ( $p < 0.001$ ) in intragroup analysis in all outcome measures after treatment in both groups with  $p < 0.001$ . Additionally, the between-group analysis revealed significantly more significant improvements in pain reduction, ROM, balance, and sports function in Group B compared to Group A.

**CONCLUSION:** Both treatments significantly improved pain, range of motion (ROM), balance, and functional outcomes. However, the group receiving neuromuscular training supplemented with Kinesio Tape exhibited greater effectiveness in ankle sprain.

**KEYWORDS:** Football player, Kinesio-Tape, Neuromuscular Training, Pain, Range of Motion

**INTRODUCTION**

Ankle inversion sprains are common in athletics, with over 40% recurring after the initial incident. Recurrent sprains may stem from mechanical instability (MI) and functional ankle instability (FAI), characterized by laxity in joint motion and sensations of ankle instability, respectively<sup>1</sup>. While MI and FAI can coexist, not all individuals with recurrent sprains exhibit gross mechanical instability. Following sprains, disrupted mechanoreceptors in ligaments and joint capsules impair joint position sense (JPS) and kinaesthetic sense, leading to improper foot positioning and delayed neuromuscular response, thereby increasing susceptibility to reinjury<sup>2</sup>. In Western countries, nearly one ankle sprain transpires daily per 10,000 persons, resulting in over two million annual treatments in emergency departments across the United States and the United Kingdom. Sport-related incidents contribute significantly, constituting 16%-40% of all trauma cases<sup>3</sup>. Athletic activity accounts for about 40% of all traumatic ankle injuries, with basketball (41.1%), American football (9.3%), and soccer (7.9%) exhibiting the highest incidence rates. Notably, ankle sprains are more prevalent among females, children, and participants in indoor and court sports<sup>4</sup>.

The management of acute ankle sprains involves a multifaceted approach. While the traditional RICE therapy lacks robust evidence, cryotherapy is commonly used for short-term pain relief and to minimize swelling<sup>5</sup>. Analgesic medications, particularly NSAIDs, offer short-term benefits but should be used cautiously due to potential adverse effects. Support is preferred over stabilization and rigid immobilization; however, ankle braces are more effective than other supports<sup>6</sup>. The initiation of weight bearing and exercise therapy depending on the progression of bony healing as well as ROM, stretching, strengthening, and neuromuscular training should be regarded as an essential issue in the treatment aimed at the improvement of the outcomes and the reduction of the frequency of the relapses. Integrating sport-specific manoeuvres in managing the injury is critical in regaining functionality and returning to the field<sup>7</sup>. MAL may be used for pain relief and enhancement of the patient's active range of motion. In summary, besides the application of these treatments, it is also critical to employ a treatment plan that is unique to every client to achieve the best results in the rehabilitation of acute ankle sprain<sup>8</sup>.

The following phase in rehabilitating ankle sprains is the neuromuscular and proprioceptive phase to regain balance and postural control. One may hypothesize that abnormal co-activation and timing of muscle activity following an injury are dangerous since they are likely to cause functional instability and high reinjury risk. These exercises are performed to decrease the level of subjectivity, improve the functional status, and minimize the rates of reoccurrence<sup>9</sup>. Social mobilization in the first week after the injury using neuromuscular training interventions has been proven to be safe and effective in enhancing higher activity without increasing pain or swelling. Thus, during the entire rehabilitation period, such exercises, including sensorimotor drills and surface-based activities, should be included to enhance the therapy results and avoid re-injury<sup>10</sup>.

Kinesio taping is immensely relevant in the treatment of ankle sprains because of the numerous purposes it serves. It helps immobilize and stabilize the ankle joint and reduces further movements that can cause harm in the healing process<sup>11</sup>. The taping technique plays a part in the alleviation of pain by managing the pressure over injured tissues and positioning the ankle joint correctly. Also, Kinesio taping increases proprioception, thus helping the body to be alert to the joint's position and movements, which aids in restoring normal muscle movements and preventing further injuries<sup>12</sup>. Further, the unique structure aids in the proper flow of lymph, helping address swelling, which is typical of an ankle sprain. It is explained, however, that while it is adherent and can stick on the skin surface for an extended period, Kinesio tape does not limit any movements as it factors

functional movements and muscle contractions into its assistance and support<sup>13</sup>. Specifically, using Kinesio taping allows patients with ankle sprains to start the therapeutic physical exercises earlier than if they had been treated conventionally, permitting them to get back to regular use of their ankles in the shortest time<sup>14</sup>.

Footballers are more vulnerable to such injuries; thus, identifying the most helpful physical therapy process could help them perform better in football-related activities and reduce the probability of recurrence of the injury. Despite these findings, this study could be helpful to clinicians in charge of formulating intervention strategies for these athletes. Thus, this study aimed to compare neuromuscular training with and without kinesio tape for footballers with ankle sprains in pain, joint range of motion, balance and functional recovery.

## METHODOLOGY

**Study Protocol:** A parallel-group, assessor-blinded, Randomized Control Trial (RCT) to assess the efficacy of interventions took place between March and August 2023 at the Pakistan Sports Board in Lahore. This clinical trial was registered with the trial registration number **NCT06198270**. Ethical approval was obtained from the research ethical committee at Riphah International University. Informed consent was obtained from all participants, and measures were taken to ensure the confidentiality and privacy of participant data. Steps were taken to minimize potential risks and protect participants from harm, providing the study was conducted fairly and unbiasedly.

**Participants:** Researchers adopted a non-probability convenient sampling strategy to enlist 38 footballers aged 18-30. Inclusion criteria required participants to have played sports for at least a year and to participate in 15–20-hour training sessions. Those meeting predetermined criteria for grade I and II ankle sprains were included. The subjects were divided into two equal groups: Group A (control group) and Group B (experimental group).

**Outcome Measurement:** The pain intensity was measured by the Numeric Pain Rating Scale (NRS), with a higher score indicating more intense pain. The ankle dorsiflexion and plantar-flexion range were measured by goniometer, and the dynamic balance was calculated using the Star Excursion Test, a lower score indicating poor balance. Ankle function is assessed by the FAAM-Sports Scale, and a higher score indicates a better functional status. The 20-m sprint test was used to calculate speed, and a lower time(sec) showed a higher speed.

### **Interventions:**

Over four weeks, each group received twelve treatment sessions. Every intervention was given one-on-one by a physiotherapist with eight years of clinical experience treating musculoskeletal diseases, particularly sports injuries and rehabilitation, and formal training in NMT. At the initial consultation, all interventions were initiated immediately following recruitment. Additionally, they were instructed to apply ice to the damaged ankle area directly for 10-15 minutes at least three times a day and to elevate their injured leg on pillows while they slept. The ankle and subtalar range of motion exercises were among the non-weight-bearing exercises performed in extended sitting positions. Each set consisted of 15 repetitions. Calf muscle stretches were performed five times and held for 30 seconds each time<sup>15</sup>. In both groups, the exercise regimen started after the first therapy session. This course was created to increase proprioception and improve ankle joint mobility and muscle strength. Patients were recommended to cease exercising if their pain

increased by more than three on the NPRS and to resume exercise only if their pain returned to baseline after five minutes. The workup settings were changed if necessary, but the kind of exercise remained the same.

Group A and B, NMT completed 12 sessions divided into 4 weeks. The intervention consisted of 6 neuromuscular exercises (3 sets, ten reps each) engaged in neuromuscular training, emphasizing activities that enhance neuromuscular control, balance, and stability<sup>16</sup>. This program included cross-arm single-leg stances, throwing/receiving a ball, single-leg deadlifts, calf lifts, lateral jumps with hands on the hip, and balancing board exercises. Improving proprioceptive awareness and sensorimotor integration in the ankle joint was the goal<sup>17</sup>. Additionally, Group B received K-Tape applications, which provide additional sensory input and support to the ankle, enhancing the effects of the neuromuscular training program. Both groups performed five sets of exercises thrice weekly over four weeks.

**Statistical Analysis:** Collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 23 with a statistical significance level set at  $p=0.05$ . Normal data distribution was assessed using the Shapiro-Wilk test, and parametric tests were applied. Independent T-test for within-group and Paired test for between-group analysis.

## RESULTS

Thirty-eight patients participated in the study, and two athletes dropped out due to long institutional distance. There were a total  $n=19$  participants in Group A &  $n=19$  participants in Group B. The demographic characteristics, expressed as means and standard deviations, provide a comprehensive overview of the study population. For the alone neuromuscular training group, the mean age was  $21.47\pm 3.11$ , with an average weight of  $61\pm 9.99$  and a height of  $5.57\pm 0.3$ . Conversely, the neuromuscular training with the kinesio-tape group exhibited a mean age of  $22.27\pm 2.58$ , a mean weight of  $62.67\pm 4.42$ , and a mean height of  $5.65\pm 0.3$  (**Table I**).

**Table I. The demographic characteristics of the subjects (Mean± Standard deviation)**

Measurement Index	Neuromuscular training (Group A)	Neuromuscular Training with Kinesio-Tape (Group B)
Age (years)	21.47 (SD = 3.11)	22.27 (SD = 2.58)
Weight (kgs)	61.0 (SD = 9.99)	62.67 (SD = 4.42)
Height (feet)	5.568 (SD = 0.3)	5.654 (SD = 0.3)

The results in **Table II** showed significant improvements across various outcome measures post-intervention. Pain intensity, as measured by the Numeric Pain Rating Scale (NPRS), significantly decreased from an average of  $3.9\pm 0.89$  to  $2.6\pm 0.83$ , with a mean difference of  $1.3\pm 0.03$  ( $p < 0.001$ ). The dorsiflexion range of motion increased from  $18.7\pm 1.44$  degrees to  $21.3\pm 1.03$  degrees, while plantar flexion improved from  $38.8\pm 1.7$  degrees to  $42.5\pm 3.2$  degrees, showing mean differences of  $2.5\pm 0.41$  and  $3.7\pm 2.5$  degrees, respectively. Balance, assessed using the Star Excursion Balance Test (SEBT), significantly improved with a mean score increase from  $48.9\pm 7.36$  to  $60.6\pm 3.9$ , resulting in a mean difference of  $11.7\pm 3.46$ . Additionally, the Foot and Ankle Ability Measure (FAAM) scores rose from  $44.7\pm 4.7$  to  $50.2\pm 5.07$ , indicating a mean difference of  $5.47\pm 0.37$ .

**Table II: Pre and Post results of neuromuscular training alone.**

Outcome measures	Pre-values	Post-values	Mean Difference	p-value
NPRS	3.9± 0.89	2.6±0.83	1.3±0.03	<b>&lt;0.001</b>
Dorsi-flexion	18.7±1.44	21.3 ±1.03	2.5±0.41	
Planter-flexion	38.8±1.7	42.5±3.2	3.7±2.5	
SEBT	48.9±7.36	60.6±3.9	11.7±3.46	
FAAM	44.7±4.7	50.2±5.07	5.47±0.37	

*NPRS= Numerical Pain Rating Scale, dorsi and planter flexion were measured in degrees, SEBT=Star Excursion Balance Test, FAAM= Foot and Ankle Ability Measure, Sports subscale*

The experimental group exhibited significant improvements across all measured outcomes following the intervention. Pain intensity, as measured by the Numeric Pain Rating Scale (NPRS), showed a dramatic reduction from a pre-intervention mean of 4.6±0.97 to a post-intervention mean of 1.0±0.76, resulting in a mean difference of 3.6±0.21 ( $p < 0.001$ ). The dorsiflexion range of motion increased significantly, with mean values rising from 19.9±1.3 degrees to 23.6±1.84 degrees, indicating a mean difference of 3.7±0.54 degrees. Similarly, plantar flexion improved substantially, with mean values increasing from 38.1±2.55 degrees to 44.9±2.87 degrees, yielding a mean difference of 6.8±0.32 degrees. The Star Excursion Balance Test (SEBT) assessed that balance improved markedly, with mean scores increasing from 46.3±6.65 to 66.9±5.4, reflecting a mean difference of 20.6±1.25. Additionally, as measured by the Foot and Ankle Ability Measure (FAAM) Sports Scale, functional performance showed a significant enhancement, with mean scores rising from 45.5±6.1 to 62.3±7.5, resulting in a mean difference of 16.87±1.4. These results underscore the intervention's effectiveness in significantly reducing pain, improving range of motion and balance, and enhancing functional performance in the experimental group. **Table III**

**Table III: Pre and Post results of Experimental Group**

Outcome measures	Pre-values	Post-values	Mean Difference	p= value
NPRS	4.6±0.97	1.0±0.76	3.6±0.21	<b>&lt;0.05</b>
Dorsi-flexion	19.9±1.3	23.6±1.84	3.7±0.54	
Planter-flexion	38.1±2.55	44.9±2.87	6.8±0.32	
SEBT	46.3±6.65	66.9±5.4	20.6±1.25	
FAAM Sports-Scale	45.5±6.1	62.3±7.5	16.87±1.4	

*NPRS= Numerical Pain Rating Scale, dorsi and planter flexion were measured in degrees, SEBT=Star Excursion Balance Test, FAAM= Foot and Ankle Ability Measure, Sports subscale*

The between-group analysis revealed that the Neuromuscular Training with Kinesio-Tape (Group B) was significantly more effective across various outcome measures than Neuromuscular Training alone (Group A). Pain intensity, as measured by the Numeric Pain Rating Scale (NPRS), showed a significantly more significant reduction in Group B (mean difference of 3.6±0.21) compared to Group A (mean difference of 1.3±0.03,  $p < 0.05$ ). Dorsiflexion range of motion improvement was more pronounced in Group B (mean difference of 3.7±0.54) than in Group A (mean difference of 2.5±0.41). Similarly, plantar flexion showed a more significant increase in Group B (mean difference of 6.8±0.32) compared to Group A (mean difference of 3.7±2.5). Balance, as assessed by the Star Excursion Balance Test (SEBT), improved significantly more in

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Group B (mean difference of 20.6±1.25) than in Group A (mean difference of 11.7±3.46). Furthermore, functional performance, measured by the Foot and Ankle Ability Measure (FAAM), showed a greater enhancement in Group B (mean difference of 16.87±1.4) compared to Group A (mean difference of 5.47±0.37). These results indicate that adding Kinesio-Tape to neuromuscular training significantly enhances the effectiveness of the intervention across all measured outcomes. **Table IV**

**Table IV: Differences of Pre & Post results between control and experimental group**

<b>Outcome measures</b>	<b>Neuromuscular training (Group A)</b>	<b>Neuromuscular Training with Kinesio-Tape (Group B)</b>	<b>Mean Difference</b>	<b>p-value</b>
NPRS	1.3±0.03	3.6±0.21	1.3±0.03	<0.05
Dorsi-flexion	2.5±0.41	3.7±0.54	2.5±0.41	
Planter-flexion	3.7±2.5	6.8±0.32	3.7±2.5	
SEBT	11.7±3.46	20.6±1.25	11.7±3.46	
FAAM	5.47±0.37	16.87±1.4	5.47±0.37	

## DISCUSSION

This study explored the effect of neuromuscular training with and without kinesio tape on pain, range of motion, balance, and function in male football players with ankle sprain. After 4 weeks of training, Results demonstrated significant improvements across various outcome measures post-intervention for both groups, with the experimental group exhibiting substantially more substantial gains. Pain intensity, as measured by the Numeric Pain Rating Scale (NPRS), showed a more pronounced reduction in the experimental group (mean difference of  $3.6 \pm 0.21$ ) compared to the control group (mean difference of  $1.3 \pm 0.03$ ,  $p < 0.05$ ). Enhancements in dorsiflexion and plantar flexion ranges of motion were more significant in the experimental group, with mean differences of  $3.7 \pm 0.54$  and  $6.8 \pm 0.32$  degrees, respectively, compared to  $2.5 \pm 0.41$  and  $3.7 \pm 2.5$  degrees in the control group. Balance improvements, assessed using the Star Excursion Balance Test (SEBT), were greater in the experimental group (mean difference of  $20.6 \pm 1.25$ ) than in the control group (mean difference of  $11.7 \pm 3.46$ ).

Furthermore, functional performance, measured by the Foot and Ankle Ability Measure (FAAM), exhibited a more substantial enhancement in the experimental group (mean difference of  $16.87 \pm 1.4$ ) compared to the control group (mean difference of  $5.47 \pm 0.37$ ). These findings indicate that adding Kinesio-Tape to neuromuscular training significantly enhances the effectiveness of the intervention across all measured outcomes. These findings align with studies emphasizing the positive impact of exercise-based interventions on pain reduction in individuals with ankle sprains<sup>18-20</sup>.

A study demonstrated a significant decrease in ankle pain after nine sessions of MWM treatment for grade two lateral ankle sprains<sup>21</sup>. In addition to ankle sprains, numerous other musculoskeletal pain conditions, including low back pain<sup>22</sup>, neck pain<sup>23</sup>, chronic musculoskeletal pain in elderly individuals<sup>24</sup>, chronic pain following primary total knee arthroplasty<sup>25</sup>, and osteoarthritis in the knee and hip, can be effectively treated with neuromuscular exercise (NME)<sup>26</sup>. It has been suggested that affected persons engage in multimodal active workouts, termed "exercise-induced hypoalgesia", because they may help control pain by lowering sensitivity to noxious stimuli and activating endogenous pain-inhibitory pathways<sup>27</sup>. In contrast, a review reported no significant change in compressive or thermal pain after one MWM session for similar injuries<sup>28</sup>. The differences in treatment duration, pain type, and dosage may explain these discrepancies.

Assessment of range of motion (ROM) in dorsiflexion and plantar flexion revealed significant improvements in both groups. Group B showed greater improvements in dorsiflexion (3.7 degrees,  $p < 0.001$ ) and plantar-flexion (6.8 degrees,  $p < 0.001$ ) compared to Group A (dorsiflexion: 2.5 degrees,  $p < 0.001$ ; plantar-flexion: 3.7 degrees,  $p < 0.001$ ). These results are consistent with studies highlighting the effectiveness of exercise interventions in improving ankle joint mobility<sup>29,30</sup>. Studies revealed that ankle inversion/eversion ROM changes were significantly lower in Kinesio-taped ankle conditions<sup>31,32</sup>.

The Star Excursion Balance Test (SEBT) results demonstrated substantial improvements in balance for both groups, with Group B showing a significantly more significant mean difference of 20.6 units ( $p < 0.001$ ) compared to Group A's mean difference of 11.7 units ( $p < 0.001$ ). The previous study examined the potential of KT to increase ankle stability through improved proprioception; KT has also been proposed to enhance muscle activation<sup>33</sup>. Current and prior studies align with the literature emphasizing the positive impact of exercise interventions, mainly neuromuscular training, on balance enhancement<sup>34,35</sup>.

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Regarding functional improvements assessed through the Foot and Ankle Ability Measure (FAAM) Sports-Subscale, both groups showed notable increases. However, Group B exhibited a significantly higher mean difference of 16.87 points ( $p < 0.001$ ) compared to Group A's mean difference of 5.47 points ( $p < 0.001$ ), indicating superior functional outcomes with Neuromuscular Training. These results resonate with research emphasizing the effectiveness of exercise interventions in enhancing functional outcomes in individuals with ankle sprains<sup>36,37</sup>. The results are also consistent with existing literature, highlighting the positive impact of targeted exercise interventions in individuals recovering from ankle sprains<sup>38,39</sup>.

The observed improvement in symptoms (pain, ROM, and balance) with neuromuscular training may be attributed to its focus on neuromuscular control and functional adaptations in individuals with ankle sprains. Future studies should investigate the sustained effectiveness of pain reduction following Neuromuscular Training compared to manual therapy and biomechanical changes in ankle sprain patients.



## **CONCLUSION**

The study concluded that both treatment groups have significantly improved the symptoms. However, integrating neuromuscular training with K-tape application exhibits heightened effectiveness in mitigating pain, enhancing range of motion (ROM), and augmenting functional outcomes, surpassing outcomes observed in the control group. This efficacy is evident in both intra-group and inter-group comparisons.

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## **AUTHOR CONTRIBUTION**

Memon AG: Conception and design, Data Analysis and interpretation, Article Drafting

Chandran SP: Conception and design, Critical revision for the important intellectual content

Annosha: Data Collection, Literature search

Zakir T: Data Collection, Assembly of data

Sulaman M: Data collection

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