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The effectiveness of core stability addition in short wave diathermy and star excursion balance exercise in improving the functional ability of chronic ankle instability among taekwondo athletes

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ABSTRACT

Background: Taekwondo is based on sudden and violent attacks by the hands and feet; therefore, an injury can occur. Ankle sprains account for 15% to 20.8% of all sports injuries, and 72% of people who have experienced an ankle sprain report experiencing chronic ankle instability. Star excursion balance exercise is an exercise that increases the functional ability of the ankle. The shortwave diathermy intervention assists the ligaments' healing process as core stability exercise is necessary to activate postural control, which is a valuable component in treating chronic ankle instability. This study aimed to determine the effectiveness of adding core stability to shortwave diathermy and star excursion balance exercise in improving the functional ability of chronic ankle instability in taekwondo.

Methods: The research used experimental research with a randomized pretest-posttest control group design. The technique used for sampling in this study is simple random sampling. There are two sample groups to be studied. The first group was given additional core stability through shortwave diathermy and star excursion balance exercise, and the second group was assigned the intervention of shortwave diathermy and star excursion balance exercise. The functional ability of the ankle is measured using the foot ankle disability index (FADI). There were 18 people in each group. The study was conducted three times a week for a month.

Results: The results showed significant differences in the two groups with $p = 0.000$. However, the intervention group was better at improving the functional ability of chronic ankle instability in taekwondo with a value of $p = 0.002$.

Conclusion: This study concludes that there are differences in adding core stability to the shortwave diathermy intervention and star excursion balance exercise in improving the functional ability of chronic ankle instability in taekwondo.

Keywords: chronic ankle instability, core stability, functional ability, short wave diathermy, star excursion balance exercise, taekwondo.

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INTRODUCTION

Taekwondo is based on sudden and violent strikes by the hands and feet.[1] The characteristics of this martial art are dynamic techniques such as mobile stance, agility, flexibility, power, and endurance. A taekwondo performing kick combinations requires mastering single-leg stance, jumping, spinning, and sliding kicks.[2] The frequency of injuries in taekwondo is to the lower limbs, 46.5 to the upper limbs, 18%; to the back, 10%. As much as head to 3.6%.[3] Research conducted by Fong et al. found that ankle sprains accounted for 15% to 20.8% of all sports injuries. It is estimated that 72% of people who have experienced a lateral ankle sprain report experiencing residual symptoms and developing a chronically unstable ankle.[4]

Chronic ankle instability (CAI) causes proprioception, neuromuscular control, postural control, and strength disturbances. The problems often found in this condition are disturbances in postural control, dynamic balance, and muscle function. Hiller's study found a significant decrease in postural stability in individuals with repetitive ankle sprains. The characteristic of this condition is a continuous feeling of instability, or what is called "giving away," that will interfere with daily activities and sports activities, especially taekwondo training, and can affect the abilities and achievements of these athletes.[5]

Physiotherapy treatment in this phenomenon can be in the form of modality therapy shortwave diathermy (SWD) as much as an exercise therapy called star excursion balance exercise (SEBT). Star excursion balance exercise causes concentric and eccentric muscle contractions simultaneously, stimulating proprioceptive and coordination.

However, it also reported that repetitive ankle sprains after giving star excursion balance exercise in 3 months of follow-up were caused by a postural sway.[6]

Postural stability was assessed by analyzing the trajectories of the center of pressure in time and frequency separately, and any increase in this parameter of the center of pressure was interpreted as a weakening of static stability or postural control. Furthermore, reduced postural control during single-leg balance has been shown repeatedly to imply a higher risk of injury in healthy ankles. Therefore, paying attention to postural stability in improving postural control is necessary, one of which is core stability training. For maximum force regulation in kinetic chain movement, core muscle stability governs movement and body position through the pelvis and legs.[7] Core stability is the principle of activating core muscles as a stabilizing component in the trunk and pelvis against limb movement patterns that will affect postural control and are used to generate rotational torque around the spine.[8]

Based on the background, this study aims to determine the effectiveness of adding core stability to shortwave diathermy and star excursion balance exercise to improve the functional ability of chronic ankle instability in taekwondo.

METHODS

This research was experimental with a randomized control group pretest and post-test design. Before patients were recruited, this study was approved by the Faculty of Medicine, Udayana University/ Sanglah Hospital, Denpasar, with ethical clearance number 1939/UN14.2.2.VII.14/ LT/2022. Respondents were explained the procedures and benefits of the research before it started. The participants in this study were the population of taekwondo in at taekwondo clubs in Denpasar City, Bali, Indonesia. The eligibility criteria in this study were subjects with an unstable chronic ankle under a score of 24 and males aged 18–24 years. Someone who has musculoskeletal injuries such as fractures, sprains, and other injuries in the leg area, open wounds in the leg area, tumors, malignancies, deformities, or anatomical abnormalities in the feet are excluded from this study.

Sampling in this study used simple random sampling. All populations that meet the eligibility criteria will become research samples. Samples will drawn from lots to enter Group 1 or Group 2. Functional ability in chronic ankle instability was measured using the foot-ankle disability index (FADI) and the Cumberland ankle instability tool (CAIT). The star excursion balance exercise is repeated ten times, three sets, three times a week, for as many as 12 treatments. Core stability exercises include bridging, plank exercises, abdominal bracing, and quadruped alternate arm and leg lifts with bracing. This technique was carried out with a hold of 10 seconds, ten repetitions, three sets, three times a week, and as many as 12 treatments. Shortwave diathermy with a frequency of 27.12 MHz with the coplanar method, continuous current, for 20–30 minutes.

The results of functional ability measurements on chronic ankle instability used values below 100 points, and the CAIT used values below 24. Look at the improvements in each of these measuring instruments. The data analysis technique used the *Wilcoxon* match pair test for Group 1 and paired samples *T*-test for Group 2 to see the difference between each group and the *Mann-Whitney U*-test to view the difference between Group 1 and Group 2, using SPSS 24 software.

RESULTS

Based on Table 1, it found that the average age in group 1 was 20.22 ± 2.211, and group 2 was 20.33 ± 1.879. The mean CAIT score in group 1 was 19.39 ± 2.704, and in group 2 was 19.56 ± 2.281. FADI score data for the difference in intervention in group 1 obtained $p<0.005$, and group 2 obtained $p>0.005$. Therefore, it stated that the difference in intervention data between groups 1 and 2 was not normally distributed. The results obtained were $p<0.005$ in the homogeneity test for differences. Therefore, it stated that the data on the difference in intervention in groups 1 and 2 is said to be homogeneous. Thus, the statistical test for Group 1 uses a non-parametric statistical test, and Group 2 uses a parametric statistical test, as shown in Table 2.

Tables 3 and 4 showed increasing functional ability in group 1 with the Wilcoxon test obtained $p<0.005$, and group 2 with the paired sample *t*-test got $p<0.005$. It stated that in group 1, core stability shortwave diathermy and star excursion balance exercises could significantly increase the functional ability of the ankle. In group 2, shortwave diathermy and star excursion balance exercises can substantially increase the helpful capacity of the ankle.

Table 5 shows that the ankle functional ability score resulted in a *p*-value <0.005,

Table 1. Characteristics of the study subjects

Characteristics	Group	
	Group 1 (n=18)	Group 2 (n=18)
	Mean±SD	Mean±SD
Age (years)	20.2±2.2	20.3±1.9
CAIT	19.4±2.7	19.6±2.3

CAIT, Cumberland ankle instability tool; SD, standard deviation

Table 2. Normality test results and FADI score homogeneity

FADI score	Data normality with *Shapiro Wilk* Test				Homogenitas with *Levene's* test
	Group 1		Group 2		
	Mean±SD	*p*-value	Mean±SD	*p*-value	*p*-value
Pre	81.8±3.2	0.055	80.8±3.0	0.026	0.509
Post	93.7±4.5	0.006	90.2±3.1	0.015	0.005
Difference	11.9±2.9	0.048	9.4±1.1	0.169	0.011

FADI, foot-ankle disability index; SD, standard deviation

Table 3. ***Wilcoxon* test in group 1**

Variable	Mean±SD	*p*-value
Pre	81.8±3.2	0.000
Post	93.7±4.5	

SD, standard deviation

Table 4. **Test paired sample *t*-test in group 2**

Variable	Mean±SD	*p*-value
Pre	80.8±3.1	0.000
Post	90.2±3.1	

SD, standard deviation

Table 5. **Test the hypothesis with the *Mann-Whitney* test in group 1 and group 2**

Variable	Group 1 Mean±SD	Group 2 Mean±SD	*p*-value
Pre	81.8±3.2	80.8±3.1	0.346
Post	93.7±4.5	90.2±3.1	0.022
Difference	11.9±2.9	9.4±1.1	0.002

SD, standard deviation

showing a significant difference between Group 1 and Group 2. From the descriptive data, the percentage increase in the FADI score in group 1 was higher than the percentage increase in the FADI score in group 2. The conclusion is that adding core stability to the intervention of shortwave diathermy and star excursion balance exercise further improves the functional ability of chronic ankle instability in taekwondo.

DISCUSSION

The core deficits associated with CAI include deficit proprioception, neuromuscular control, strength, and postural control.[9] SWD will provide a heating effect so that it reduces the viscosity of the matrix in the tissue, which will increase muscle elasticity, vasodilation of blood vessels to eliminate receptor stimulating factors by facilitating removal, and muscle tone will decrease through normalization of nonsensory in nociceptors so that receptor stimulation decreases and decreases gamma motor neuron activity so that pain decrease.[10]

SEBT will have a neurophysiological effect on the somatosensory mechanism of postural control. During the reach, it will activate the proprioceptive joints so that there is postural control in maintaining balance. Besides that, it will also activate different muscles in each reaching, increase muscle strength in maintaining balance, and ultimately improve the functional ability of the CAI.[6] Core stabilization training results in the activation of the core muscles when performing functioning activities. Dynamic joint restraint results from feed-forward and feedback neuromotor control over the skeletal muscles across the joint. Feed-forward control is a preparatory action that occurs before sensory information is detected. In contrast, feedback control is a corrective response that adjusts to coordinate muscle activity after catching sensory information.[8]

The results of research from Masiero et al. (2019) show that SWD effectively and safely reduces pain and improves the quality of life in people with musculoskeletal disorders.[10] The effect given by SWD is to reduce the degree of pain, providing a heating effect so that it influences the connective tissue, which will decrease matrix viscosity so that elasticity will increase as long as with an increase in muscle elasticity, muscle tone will decrease through nonsensory normalization in nociceptors so that receptor excitability decreases, eliminating receptor stimulating factors by facilitating disposal through blood circulation, and reduce the activity of gamma motor neurons so that the pain decrease. When the pain and spasm decrease, the range of motion of joints will increase, and repairs in connective tissue will be able to increase muscle strength.[11] Continuous personalized SWD is effective and safe for treating pain in patients with musculoskeletal disorders.[12]

The goal of balance training should be to reduce the time between nerve excitability and muscle response because the usefulness of neuromuscular training programs has a potential effect to change college athletic movement strategies, improve performance, decrease athletes' movement strategies, and reduce athletes' risk for injury.[13] SEBT implanted with the paradigm of open and closed eyes proved more effective for restoring functional stability than conventional therapy after ankle sprains.[6] Similarly, a 4-week balance-specific training program can benefit athletes suffering from chronic ankle instability.[14] The increase in range excursion distance was found in the right posterolateral direction compared to the right posteromedial and right anterior directions because excursions involve movements in three planes, and SEBT involves eight types of complex movement performed by the body. So, SEBT could effectively improve dynamic posture control among collegiate female athletes.[6]

The finding of this effect agrees with a study conducted by Sabin (2011) showing that performance during SEBT, as measured by spanning distance, is higher on stable surfaces than on unstable surfaces in all directions, with insignificant results only in the anterior as a direction. The neurophysiology behind this is the somatosensory mechanism of postural control. The unstable testing surfaces have been speculated to challenge the somatosensory tool by increasing the difficulty of maintaining balance so that the results are more significant on a stable surface than in an unstable layer.[15] Different muscles are activated during a reach, as proposed by Earl and Hertel (2001). It is found that each direction of reaching activates muscles of the lower limb stance to a different degree. They reported that the order of the anterior reaching, the vastus medialis, and lateralis were most active. The most active are the posterolateral reach, the biceps femoris, and the tibialis anterior. The tibialis anterior is most active in the posteromedial direction.[16]

Kibler (2006) stated that deep muscle strengthening further affects stabilization by the trunk region. The abdominal muscles consist of the transverse abdominis, the internal and external obliques, and the rectus abdominis, as a contraction of the transverse abdominis increases intra-abdominal pressure and tension of the thoracolumbar fascia. The transverse abdominis is beneficial in stabilizing the lumbar spine.[8] Abdominal muscle contractions help stiffen the cylinders, increasing the rigidity of the lumbar spine. The rectus abdominis and abdominal obliques activated in a direction-specific pattern concerning limb movement by providing postural support before limb movement. Several studies claim that core stabilization training can result in better activation patterns for the trunk muscles. That may mean that core stabilization training leads to better activation and greater strength in the trunk muscles.[17] Based on Kibler's (2006) findings, core muscle activation in limb movement patterns leads to better postural control muscle activation, which can generate rotational torque around the spine.[8]

Marshal and Murphy (2003) demonstrated that core stabilization training activates the upper-level muscles of the lumbar hip region when performing functional activities.[18] Dynamic joint restraint results from feed-forward and feedback neuromotor control over the skeletal muscles across the joint. Feed-forward control is a preparatory action that occurs before sensory information is detected. In contrast, feedback control is a corrective response that adjusts to coordinate muscle activity after catching sensory information. Movement at the ankle generates higher central nervous system somatosensory awareness, and messages are sent to the muscles around the ankle in response to the activities. The reactions from proximal to distal refer to strengthening the proximal muscles, which helps prevent or heal CAI.[17]

Riemann's (2002) study was conducted to analyze the relationship between ankle instability and core strength. The hips, pelvis, and spine all provide a stabilizing function, allowing the limbs to perform certain operations. Core strength is a significant factor in spinal and pelvic stabilization, as well as the generation and transfer of energy from the large body parts to the smaller body parts.[19] The idea that core strength is a factor in CAI is suggested by the relationship between the trunk, pelvis, and extremities. Strength in the hip is essential for gait mechanics and foot position during the heel strike; weakness in these muscles can lead to improper foot placement and cause the ankle to roll or twist.[20,21]

Recent research by Cejudo, de Baranda, Santonja, and Ayala (2016), who presented multiple hip abductor motion tests in athletes to prevent sports-related injuries, confirms the study results.[22] With the core stability mechanism, some chronic ankle instability problems can be resolved functionally. Thus, these conditions can improve functional abilities in patients with chronic ankle instability and allow them to do activities or exercise optimally.[8]

There are some limitations to this study. First, the number of samples is restricted. A multicenter investigation with a bigger sample size is required to confirm our findings. Second, the study was conducted for one month because of the limited study time and the inability to evaluate the long-term effects of therapy. Third, this study could not monitor control variables such as patient's daily activities, nutrition, exercise intensity, and smoking habits. Further research is needed regarding variables that can become confounders, namely the patient's daily activities, nutrition, exercise intensity, and smoking habits, and the need for mid-term and long-term follow-up regarding the effects of core stability.

CONCLUSION

This study concludes that adding core stability to shortwave diathermy and star excursion balance exercises significantly increases the functional ability of chronic ankle instability in taekwondo.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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ETHICAL CONSIDERATION

The Commission for Research Ethics, Faculty of Medicine, Udayana University / Sanglah Hospital, Denpasar, with ethical clearance number 1939/UN14.2.2.VII.14/LT/2022.

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AUTHOR CONTRIBUTIONS

IDGAK compiled the study design, data collection, and data analysis and drafted the manuscript; AAGESU, MW, and IPYPP participated in the literature search, drafting, and revising of the manuscript. All authors have read and approved the final version of the manuscript.

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