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The Influence of Proprioceptive Training in Foot and Ankle Disability with Chronic Ankle Sprain

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ABSTRACT

Introduction: Chronic ankle sprain is an injury to the lateral complex ligament long lasting with complaints of pain. The chronic inflammation and instability in carrying out activities are caused by ligamentous weakness and decreased function including sensorimotor deficits. It can cause a decrease in proprioception and disability. Meanwhile, foot and ankle disability are characterized by inability to carry out movements and functional activities. **Objective:** This study is aimed at comparing the effect of proprioception exercise with wobble board that has the same effect with elastic resistance band and to strengthen the ankle muscle in decreasing foot and ankle disability caused by chronic ankle sprain condition**. Methods:** The study design is true experimental with randomized pre and post-test group design for 20 patients (12 men, 8 women, age 21.70±4.90, weight 56.20±5.43, height 158.90±5.15, BMI 20.761±1.86), the training group was done 18 times over 6 weeks using Foot And Ankle Disability Index (FADI) for its measurement. **Results:** This study reported parametric between statistical analysis and paired sample-test. Hypothesis test showed that the two groups had significant results in decreasing foot and ankle disability, the pre-A group result is 25.90±15.56 and the post group 6.60±5.03. Meanwhile, pre B group averaged 44.90±18.80 and the post group 13.10±10.304 with p-value=0.001 and p-value<0.05. Different test with independent sample t-test produced significant differences from the two groups which are in A group 19.30±12.59, B group 31.10±12.19 and p-value=0.047 in p-value<0.05. **Conclusion:** In order to provide appropriate treatment, clinicians can use any of the two significant measures with their associated Foot And Ankle Disability Index scores to identify those who could benefit from rehabilitation of chronic ankle sprain according to needs with regards to age, network conditions, workload, and position at work.

Keywords
Proprioceptive training, Wobble board, Elastic resistance, Chronic ankle sprain

Introduction

Chronic ankle sprain is caused by frequent ankle sprain. Recently, a prevalence study among high school and collegiate athletes identified chronic ankle sprain in 23.4% of all participants based on questionnaires [1]. The high prevalence of chronic ankle sprain is caused by an unclear multifactorial underlying mechanism, which complicates accurate treatment [2]. The functional ankle instability has been attributed to a combination of disability in proprioception, neuromuscular control, strength and postural control [3]. Different treatment protocols aim at improving these inadequacies by using a variety of exercise types (e.g., proprioceptive, balance, strength and functional training). However, there is a lack of consensus [4,5]. One of the aforementioned mechanisms associated with chronic ankle sprain is an impaired postural control. It has been repeatedly demonstrated in subjects with chronic ankle sprain [6] and is believed to be the result of a combination between impaired proprioception and neuromuscular control [3]. In literature, studies on chronic ankle sprain have investigated both static and dynamic in order to measure and evaluate proprioception, while dynamic measures have proven to be more consistent in identifying postural control disability in subjects with chronic ankle instability [7].

Proprioception can be impaired in gradual-onset of musculoskeletal pain disorders following trauma. Thus, understanding of the role of proprioception in sensorimotor dysfunction and methods for assessment and interventions is a vital importance in musculoskeletal rehabilitation. Proprioception is an essential for well- adapted sensorimotor control. Proprioception fulfills roles in feedback and feedforward sensorimotor control and regulation of muscle stiffness that is very important for movement acuity, joint stability, coordination, and balance. Furthermore, cervical proprioception is so important for head- eye co- ordination and movement control. It can be disturbed in musculoskeletal disorders due to pain, effusion, trauma, and fatigue. A variety of assessment procedures and interventions have been developed to specifically test and enhance proprioception, respectively. It is presented by an overview of clinical assessment and intervention methods for proprioception of the spine and extremities. Reference is made for research where interventions have been reported to demonstrate positive effects on proprioception especially on exercise therapy.

According to the World Conference for Physical Therapy (WCPT) , disability is when individuals cannot afford to pursue social and cultural activities in work, community, or hobby- related categories. Foot and ankle disability can be measured through the physiotherapy procedure on the ankle and foot and its intensity can be measured by (Foot / Ankle Disability index). FADI is a questionnaire that contains 26 items of patient activities such as 4 pain intensity and 24 daily activities [8], FADI reports the measurement of disability related to certain conditions and body parts with special steps. FADI was first described by [8], was used to assess daily activities. Based on Hale and Hartel [9], the average results of FADI was $\mu 1 = 87.1$, Standard deviation $\sigma = 12.1$ mean, $\mu 2 = 104.52$. Patients are asked to choose one of the statements marking N/A, in the box provided. Each item is on a scale of 0-4 and results 0 (able to do) to 4 (unable to do at all)/4 pain items from FADI that print 0 (no pain) to 4 (unbearable pain) . Researchers who designed this scale, reported that this measurement was more accurate and valid in patients with musculoskeletal conditions of the lower limb [9].

Functional approaches are needed in daily activities comprehensively. In dealing with chronic ankle sprain, the physiotherapy approach is needed too in line with the criteria of ICF (International Classification of Functioning, Disability and Health) , namely the impairment- based category of stability and the complement of ICD (International Classification of Disease and Related Problems) , namely category of sprain of ankle [10]. Exercise therapy is intervention to handle foot and ankle disability in chronic ankle sprain which is one of the modalities of physiotherapy to restore muscles, ligaments, tendons, bones and nerves for increasing ROM and muscle strength, enhancing proprioceptive abilities, restoring postural balance and control, and reducing foot and ankle disability so the daily activity will return to normal [11].

Proprioceptive training using the wobble board is the provision of training using a wobble board. Wobble board training is a dynamic stabilization exercise in static body position, namely the body's ability to maintain stabilization in a fixed position by standing one or two feet above the wobble board [12] . The advantages of proprioceptive training with the wobble board are that they train the muscles of the lower extremities from the pelvis to the foot and ankle simultaneously in increasing muscle strength of the foot and ankle, proprioceptive stability, balance so, the foot and ankle disability decreases into normal daily activities [11] . The principle of this exercise is to improve the function of the body's balance controller. When the exercise takes place stimuli received intrafusal fibers and extrafusal enrich sensory input that will be sent and processed in the brain to be processed so that it can determine how much muscle contraction can be given. Some responses sent back to extrafusal will activate Golgi tendon then there will be improved coordination of intrafusal fibers (myofibrils) and extrafusal fibers (organ Golgi tendons) with afferent nerves that are in muscle spindles so that good proprioceptive forms are achieved [13].

Training in strengthening the ankle muscles using elastic rubber resistance aims to increase the strength of the driving muscles of the foot and ankle, so as to be able to maintain anatomical position, increase muscle tone, increase stretch reflexes that can prevent re- injury, and improve foot stability [5] . Muscle strengthening training using elastic rubber resistance, in the form of isotonic exercises can help and improve muscle weakness caused by damage to the complex lateral ligament. Increased muscle strength is obtained through continuous training so that tonic muscle strength can increase capillary blood circulation which can increase phasic muscle strength which will result in the addition of a motor unit recruitment in the muscle that will activate the Golgi body so that the muscles will work optimally, resulting in stability both in the ankle, in decreasing foot and ankle disability in cases of chronic ankle sprain [5].

Proprioceptive training can consider any active exercise because it will generate a barrage of afferent impulses to the CNS from joint and muscle-tendon mechanoreceptors [14,15]. Thus, active exercises would seem a vital component in augmenting proprioception [15] . There is, however, the goal of our study of proprioceptive training using a wobble board which is different from ankle muscle strengthening training using elastic rubber resistance in lowering the foot and ankle disability in cases of chronic ankle sprain.

The hypothesis of our study was to assess 1) For group comparisons of those involved in chronic ankle sprain to the control involving ankle proprioceptive training using the wobble board can reduce foot and ankle disability in cases of chronic ankle

sprain; but due to the exploratory nature of this study, we do not know which variables these will be. 2) For group comparisons of those involved in chronic ankle sprain to the control involving ankle training in strengthening ankle muscles using elastic rubber resistance can reduce foot and ankle disability in cases of chronic ankle sprain; but due to the exploratory nature of this study we do not know which variables these will be and 3) For the correlation analyses, proprioceptive training using wobble board is different from ankle muscle strengthening training using elastic rubber in reducing foot and ankle disability in cases of chronic ankle sprain; but due to the exploratory nature of this study we do not know which correlations these will be.

Methods

This study was a true experimental with randomized pre and post-test group. There were two groups, first is treatment group with wobble board training and second is the group with elastic resistance training. In case of chronic ankle sprain, the most unstable ankle was selected for screening and analysis based on medical history. This study used 20 subjects (participants) with chronic ankle sprain (12 men, 8 women range age 21.70±4.90, weight 56.20±5.43, height 158.90±5.15, BMI 20.761±1.86) who volunteered to participate in our repeated measure design. To be eligible, subjects had to meet all of the following inclusion criteria: having a history of a severe ankle sprain resulting in prohibiting participation in sports, recreational or other activities for at least 3 weeks; episodes of giving way; repetitive ankle sprains; subjects filled out an ankle instability questionnaire [16], which contained the criteria for chronic ankle sprain classification of instability and weakness around the ankle joint ; being recreationally active defined by a minimum of 1.5 h of cardiovascular activity a week. Exclusion criteria were ankle fracture or surgery, lower limb complaints at the moment of testing (not related to chronic ankle sprain), and equilibrium disorders. All subjects gave their written informed consent. Foot and Ankle Disability Index (FADI) was scored on a scale of 0-4 for each question in regards to the participants' left and right ankle, with higher scores indicating increased levels of instability. Participants were classified into 2 groups: A group (having a history of sprain and FADI ≤13 with wobble board training) and B group (having history of ankle sprain within the past year and FADI ≥13 with elastic resistance training).

Wobble board training

Proprioceptive training with a wobble board is a dynamic stabilization exercise in a static body position that is the body's ability to maintain stabilization in a fixed position by standing one or two feet above the wobble board. The principle of this exercise is to improve the body's balance control function. Stabilization exercises using a wobble board involves the patient standing in one position with one or both legs. Proprioceptive training with a wobble board is performed with a frequency of exercises 3 times a week at 1-day interval, for 6 weeks, and 6 types of training: Side-to-side Edge Taps, Side-to-side Edge Front Taps, Front-to-back Edge Taps, Edge Circles, Static Standing Exercises, Partial Squat Exercises.

Elastic rubber resistance training

Training for strengthening ankle muscles with elastic rubber resistance aims to maintain muscle mass, rehabilitate and restore muscle and body functions, increase strength dynamic, increasing stability, using prisoners from external force. The ankle muscle strengthening exercises with elastic rubber resistance involves movement of ankle to dorsal and resistance with elastic rubber resistant to plantar flexion, movement of the ankle into the plantar flexion and resistance of elastic rubber resistant to dorsal flexion, ankle inversion movement and elastic rubber resistance eversion, ankle eversion movement and resistance to elastic rubber resistance inverse.

Outcome measures

The primary outcome was the Foot and Ankle Disability Index (FADI; [8] which is a region-specific self-reported measure of function based on 2 components: activities of daily living, and the more difficult sport-related tasks, and has been shown to be reliable in the ankle-sprain population. Secondary outcomes included: functional outcomes such as recurrent injury for twelve months, to provide insight into the potential effectiveness of proprioceptive exercise as a preventative measure for future injury.

Table 1 Characteristics of participants

Characteristic	Range	Kelompok A		Kelompok B	
		n	%	n	%
Age	16-25	9	45	9	45
	26-35	1	5	1	5
Gender	Man	6	60	6	60
	Women	4	40	4	40
BMI	17.00-18.40	0	0	1	5
	18.50-25.00	8	4	9	45
	25.1-27.00	1	5	1	5
Occupation	Student	0	0	1	5
	Staff	8	4	9	45
	Lecturer	1	5	1	5
Hobby	Soccer	2	10	0	0
	Futsal	4	20	4	20
	Volleyball	1	5	1	5
	Basketball	1	5	0	0
	Tennis	1	5	1	5
	Badminton	0	0	1	5

Results

Table 1 shows the characteristics of respondents related to age, body weight, height, and body mass index both in the proprioceptive training

group with the wobble board, as well as in the muscle strengthening training group with elastic resistance in the highest percentage of age in this study. That is around 16-25 years. This age is the final age group of teens who have high physical activity.

position by standing one or two feet above the shake board. The principle of this exercise is to improve the body's balance control functions, namely sensory information systems, central processors, and effectors to be able to adapt to environmental changes. When the

Table 2 Before and after foot and ankle disability index intervention

FADI	Mean±SD		Mean±SD		Homogenitas
	Group I	p-value	Group II	p-value	*Levene's Test*
Normalitas and Homogenitas test (before)	25.90±15.57	0.041*	44.90±18.80	0.867	0.517
Normalitas and Homogenitas test (after)	6.60±5.04	0.330	13.80±10.30	0.578	0.039*
Range	19.30±12.57	0.083	31.10±12.19	0.452	0.984
Pre-test	25.90±15.57	0.024*	44.90±18.78	0.024*	
Post-test	19.30±12.57	0.047*	31.10±12.19	0.047*	
t-test	6.60±5.03	0.063	13.80±10.30	0.063	

We found that the group with proprioceptive training with a wobble board could reduce Foot and Ankle Disability in cases of chronic ankle sprain with a significant value of p-value=0.063 (p-value<0.05) as well as those who practiced elastic rubber resistance (Table 2). The decrease in the foot and ankle disability values of the two groups showed no significant difference in cases of chronic ankle sprain but we found that there was a significant difference between proprioceptive training using a wobble board group (19.30±12.57) and muscle strengthening training with elastic rubber resistance group (31.10±12.19) in cases of chronic ankle sprain (p-value=0.047 (p-value<0.05).

Discussion

This study reported that the difference in mean before and after the treatment obtained an average reduction in foot and ankle disability data was obtained before treatment 25.90±15.56 and after treatment 6.60±15.56 in A Group treatment with a value of p-value=0.063 (p-value<0.05). This explains that the decrease in the foot and ankle disability values of the two groups showed no significant difference in the case of a chronic ankle sprain. Proprioceptive training using a sway board can significantly reduce foot and ankle defects in patients with chronic ankle sprain, foot and ankle imbalances because the exercise program is carried out progressively from week 1 to week 6, with a frequency of 3 times per week.

This research finding supports the finding of the research by Hale et al., [9], 34 male and female subjects were divided into two groups, group A was given training with sway boards and group B completed the study with wobble board training interventions with a frequency of 2x per week for 4 weeks. The results showed significant improvements in the treatment group with a value of p-value<0.005.

According to Hupperets et al, [17] proprioceptive training with a sway board is a dynamic stabilization exercise in a static body position, that is, the body's ability to maintain stabilization in a fixed exercise takes place, stimulation receives intrafusal fibre and extrafusal sensory input that will be sent and processed in the brain to be processed so that it can determine how much muscle contraction can be given. Some responses sent back to the extrafusal will activate the Golgi tendon then there will be increased coordination of intrafusal fibres (myofibrils) and extrafusal fibres (Golgi tendon organs) with afferent nerves in the spindle muscles so that good proprioceptive forms are achieved. Inconsistent stimulation due to surface instability received by muscles and joints has a very fast effect in capturing sensory information and is more efficiently processed in the central nervous system, so as to stimulate the mechanoreceptors in the joints. The result of deformed leg and ankle defects in patients with chronic ankle sprains because of practicing on the board by shaking the muscles of the lower extremities from the pelvis to the ankle simultaneously will contract, thereby increasing the work of the muscles and ligaments which can increase awareness of stability of the body movements that hold firm to maintain body position to remain stable. In subjects who do sway board training according to the physiotherapy program, they will avoid repeated injuries and will return to normal activities without complaints of pain due to chronic ankle sprain sprains [14].

Decreasing the value of foot and ankle disability can be seen in Table 2. The value of p-value =0.001 where p-value<0.05 means that Ho is rejected, and Ha is accepted which shows that there is a difference before and after treatment of B group. The chronic ankle sprain occurs due to muscle weakness and ligament weakness with muscle strengthening training using elastic rubber resistance, in the form of isotonic exercises can help and correct muscle weakness caused by damage to the complex lateral ligaments. Increasing muscle strength obtained with training with a frequency of 3x/ week for 6 weeks by increasing tonic muscle strength can increase capillary blood circulation. It also can increase phasic muscle strength which will result in

the addition of a motor unit recruitment in the muscle and it will activate the Golgi body, so that the muscles will work optimally. With the increase in ankle muscle strength, the ankle function as a support for the body will work more efficiently so that it is more stable and lowers the foot and ankle disability, which is capable of carrying out normal daily activities [5].

This research finding supports the study of Han and Ricard [4]. This study explains that training with elastic resistance to the ankle for 6 weeks at a dose of 3x per week, as many as 3 sets with 10 repetitions, can increase the muscle strength of the foot and ankle. Table 2. Obtained values using the Independent t-test shows the value of p-value= 0 . 047 where p-value<0. 05, It means that there is a significant decrease in the value of foot and ankle disability in both A group and B group. Whereas, in the test of Hypothesis III, it shows differences in effects between A group and B group that the muscle strengthening treatment using elastic rubber is better at lowering foot and ankle disability compared to proprioceptive training using a wobble board in cases of chronic ankle sprain. The results of the data analysis of the two groups were significantly affected by the dose. The measurements in this study indicate a difference in exercise intensity of A group and B group. In A group, week 1: 1 set: done for 15 seconds, week 2-3: 1 set: done for 30 seconds, week 4: 1 set: done for 45 seconds, week 5-6: 1 set: done for 1 minute by minute dosage. In B group, the intensity and dose of frequency training were given three times a week, the intensity of 3 sets of exercises was 30 minutes with 10 repetitions. It is viewed by the intensity in both groups that the training using a wobble board did not show a clear amount of repetition (in seconds), the progress of the exercise that is done using a wobble board cannot be observed properly. Therefore, it is assumed that training using a wobble board does not show progression as in muscle training using elastic rubber resistance. This shows that muscle strengthening training using elastic resistance is better than proprioceptive training using wobble board. It is seen based on the benefits and principles of training in the provision of proprioceptive training using the wobble board, the principle of exercise to improve proprioception and balance so that coordination of the work of the muscles and ankle and foot ligaments may improve. This will improve stability, balance, and functional movements in the foot and ankle. Besides, the same effect is obtained from the ankle muscle strengthening training using an elastic rubber with the principle of increasing ankle muscle strength when the muscles in the foot and ankle become stronger, the ligaments in the joints will be stable, so that the ankle function as a buffer can maintain the body position while moving. This can decrease the foot and ankle disability, so that the subject can return to normal activities.

From this, it means that the average sample of the category for the first and second-degree ankle sprain, namely the presence of muscle weakness and ligamentous weakness, with the oldest age of 16–25 years at that age level of balance disorders is very minimal. In addition, the level of activity or work that is less controlled in each individual can also affect the occurrence of repeated injuries that slows down the repair process of the injured tissue. According to Hyeyoung, [18] prevention of chronic ankle sprain injury requires special training to avoid re- injury because in general, the injury that occurs to the ankle is a sprain. Through proprioceptive training and training in strengthening ankle muscles with elastic resistance, neuromuscular balance and control will improve and result in a decrease in foot and ankle disability with the return of movement efficiency and normal activity.

Conclusions

Proprioceptive training methods using a wobble board and ankle muscle strengthening training with rubber elastic resistance can be used in cases of chronic sprain ankles, for physiotherapists need to consider the patient's socio-economic condition.

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