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EFFECT OF NEUROMUSCULAR TRAINING ON BALANCE AMONG UNIVERSITY ATHLETES

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ABSTRACT

Background: Proprioceptive deficiency followed by lateral ankle sprain leads to poor balance is not uncommon. It has been linked with increased injury risk among young athletes. Introducing neuromuscular training programs for this have been believed as one of the means of injury prevention. Hence, this study was aimed to determine the effects of six weeks progressive neuromuscular training (PNM Training) on static balance gains among the young athletes with a previous history of ankle sprains.

Methods: This study was an experimental study design, with pre and post test method to determine the effects of PNM Training on static balance gains. All data were collected at university's sports rehabilitation lab before and after six weeks of intervention period. There were 20 male and female volunteer young athletes (20.9 ± 0.85 years of age) with a previous history of ankle sprain involving various sports were recruited from the University community. All the subjects were participated in a six week PNM Training that included stability, strength and power training. Outcome measures were collected by calculating the errors on balance error scoring system made by the athletes on static balance before and after the six weeks of intervention period. Static balance was tested in firm and foam surfaces and recorded accordingly.

Results: The researchers found a significant decrease (2.40 ± 0.82) in total errors among the samples at the post test compared with their pre test ($P > 0.05$).

Conclusions: The study demonstrates that a PNM Training can improve the static balance on both the firm and foam surfaces among the young athletes with a previous history of ankle sprains.

Keywords: lateral ankle sprains, static balance, BESS, neuromuscular

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INTRODUCTION

Ankle injuries are very frequent in younger and active individuals not only because of sporting activities but also in recreational and leisure activities. Lateral ankle sprains (LAS) are accounted for 85% of ankle injuries [1]. They are especially common in sports requiring frequent jumping, directional changes and pivoting such as basketball, netball and volleyball [2]. The initial injury to the lateral ligaments of the ankle may lead to mechanical instability and however, associated injury to the muscles, tendons, and ankle proprioceptors may also lead to functional instability characterized by the neuromuscular dysfunction, increasing susceptibility of the cause further injury to the same ankle [3]. Thus, the history of previous injury to ankle is one of the risk factor, as there is an obvious augment injury rate during the first six to 12 months after an ankle sprain [4]. Mechanical instability refers to measurable laxity of the joint and the functional instability refers to impaired proprioception, neuromuscular control, postural sway and strength [5]. Even though both are linked [6] they can exist independently each other [7]. The bony arrangements, ligaments, musculatures and the proprioceptors around the ankle joint are responsible for the stability of the ankle joint. These are serving into avoid disproportionate inversion and eversion movements of the foot that result in injury, but they do not put off ankle injuries from being the most common injury in sports [8]. The responsibility of the muscle and its quick proprioceptive responses to extreme foot movements has not been well recognized, particularly in young athletes [2]. Therefore, there has been a drive toward identifying mechanisms of preventing many of these injuries, with one focus being the incorporation of neuromuscular training programs. Neuromuscular training aims to improve neuromuscular control, thus increasing functional joint stability [9] and balance, which may have a protective effect against injury. These training programs typically incorporate strengthening, stretching, plyometric, and balance components [10]. The inclusion of neuromuscular training is thought to develop the co-activation of the muscles surrounding joints, increasing joint stiffness and active joint stability [11].

The ability to maintain the body's centre of gravity within its base of support is known as balance. Balance can be considered as either static or dynamic balance. The ability to sustain the body in static equilibrium or within its base of support is defined as static balance [12]. Poor balance linked with increased risk of ankle injuries among both male adult [13, 14, 15] and male and female young athletes [16].

In 2004 Paterno et al, [17], found improvements in single-limb total stability and anteroposterior stability in female high school athletes after a 6-week neuromuscular-training program. In addition, improvements in strength, vertical-jump height, mediolateral stability, and maximal bench press, hang clean, and parallel squats were found in female athletes who participated in either a balance-based or plyometrics-based training program [18]. It

has been hypothesized that musculoskeletal growth during adolescence without equal neuromuscular development may result in neuromuscular imbalances that make the individual more susceptible to injury [19]. There is some indication that it is most advantageous to begin neuromuscular training during adolescence to train the body during a time of rapid musculoskeletal growth and decreased balance and coordination that occurs as a result of that growth [20]. Therefore, the initiation of these programs in interscholastic athletic programs would be warranted [21]. Thus, the purpose of the study was to determine the effects of six weeks progressive neuromuscular training (PNM Training) on static balance gains among the young athletes with a previous history of ankle sprains.

MATERIALS AND METHODS

Subjects

The subjects for this study were recruited from the University community with the age range from 20-22 years. Twenty athletes who graduated recently from the high school and registered in University Pendidikan Sultan Idris as a student were selected as samples by purposive sampling technique. Both male and female athletes were participated as volunteer subject for this study. Samples were selected based on the following criteria: must participated in any organized non-contact sports in school level, currently active in any competitive non-contact sports, and with the previous history of unilateral lateral ankle sprains within six months during the study period. The subjects were excluded if they have any other lower limb injury with in past one year, bilateral lateral ankle sprains and with the history of head injury or concussion. The injury assessment was conducted and confirmed by the Physiotherapist who was appointed to assess the injury profile before and after the intervention programme. Before participation, each subject was asked to read and sign an informed consent form. The aim of the study was explained to every subject. This study was approved by the institutional review board and received University Research Grant.

Instrumentation

The static balances of the subjects were assessed by using balance error scoring system (BESS) which has excellent interrater reliability (ICC = 0.78-0.96). [22]. The BESS test consists of six separate 20-second balance tests that the subject performed in different stances and on different surfaces. Before administrated the BESS test, the following materials were prepared and collected: foam pad (Power Systems Airex Balance Pad 81000), stop watch, spotter, BESS Testing Protocol, BESS Score Card. Before testing, the samples were instructed to remove shoes and any ankle taping if any. Wearing stockings were allowed if desired. The test consists of three stance conditions; double-leg, single-leg, and tandem stance on firm and foam surfaces individually. The subjects were instructed by the assessor about how to perform the BESS. The subjects were needed to stand by closing their eyes on three different stances for 20 seconds on two different surfaces separately. Each of the

20-second trials was scored by counting the errors, or deviations from the proper stance, accumulated by the subject. The assessor started counting errors only after the subject had assumed the proper testing position. An error was credited to the subject when any of the following occur: moving the hands off of the iliac crests, opening the eyes, step stumble or fall, abduction or flexion of the hip beyond 30°, lifting the forefoot or heel off of the testing surface, remaining out of the proper testing position for greater than 5 seconds. The maximum total number of errors for any single condition was 10 [23]. If a subject committed multiple errors simultaneously, only one error was recorded. Subjects were allowed to practice the testing protocols for two times to familiarize with the testing protocols. Then the assessor performed the test trails for the subjects. The sum of the errors made by the subjects was recorded as Pre-test score.

Then the subjects were instructed to follow the PNM Training for of three sessions per week for six weeks. During each session subjects were begun with a 10-minute warm-up consisting of jogging, side shuffles, cariocas, and stretches. Subjects then performed the PNM Training protocol. This PNM Training was based on the optimum performance training model which consists of stabilization, strength and power in three levels. Exercises were progressed from simplistic nature to increasingly complex nature. They finished with of cool down stretches. After six weeks of PNM Training the assessor performed the test trails again for the post test score.

Statistical analysis

Data analysis was performed by SPSS (version 20) for windows. Descriptive statistics including the mean and standard deviation was used to describe the general characters of the subject and outcomes variable. Paired t-test was used to measure the significant differences between the pre and post test scores. The P value < 0.05 was taken as significant.

RESULTS

Totally 13 male and 7 female subjects were participated in this study. The mean age of the subjects was 20.9 (± 0.85) years, the mean height of the subjects was 163.35 (± 8.69) centimetres and the mean weight of the subjects were 62.16 (± 1.51) kilograms. The results of statistical analysis of this study are shown in the table 1.

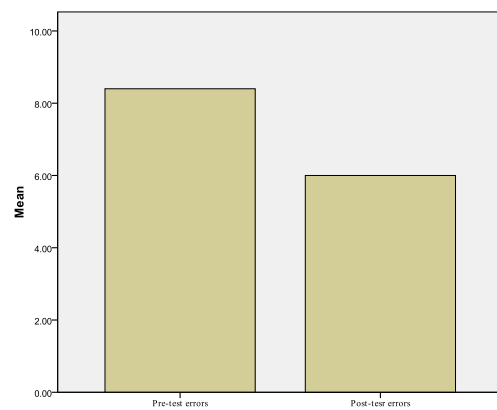
Table 1: Comparing mean value for the pre-test and post-test scores for BESS

Variable	Pre -test		Post-test		t	Sig. (2-tailed)
	Mean	SD	Mean	SD		
BESS	8.40	± 1.27	6.00	1.16	13.07	.00

SD: Standard Deviation; Sig: Significance

There was a significant difference between pre-test errors (8.40 ± 1.27) and post-test errors (6.00 ± 1.16) made by the subjects on BESS as P > 0.05.

Figure 1: Mean errors Comparison



DISCUSSIONS

The purpose of this study was to determine the effects of six weeks progressive neuromuscular training (PNM Training) on static balance gains among the young athletes with a previous history of ankle sprains. The primary finding of our study demonstrated that the improvement in the static balance by reduction in the errors made by the young athletes who had the previous history of ankle sprain. This was supported by studies carried out by Hoffman and Payne (1995), Hrysomallis (2007) and Mchugh et al. (2007) on different populations [24, 25, and 26]. These authors mentioned that the balance improvement protects athletes from for the forthcoming injuries. Since the proprioception is a neurological process, which is important to maintain the body in upright position that is in balanced position. Thus, the introductions of proprioceptive exercises are imperative to improve balance by training the proprioceptive pathways under various competitive situations. While performing these types of proprioceptive neuromuscular training, the proprioceptors, the mechanoreceptors within the muscles, tendons are activated faster and effective manner [27] and reduction in time between the neural stimuli and muscular response [28]. Furthermore the results of the current study also show the same effect by reducing the number errors consequently improving static balances on different surfaces.

According to Hewett, Paterno, Myer (2002) the musculoskeletal growth during adolescence without equal neuromuscular development may result in neuromuscular imbalances that make the individual more susceptible to injury [19]. Hence the adolescent and young athletes who had the previous history of lateral ankle sprain they might develop unequal neuromuscular development and so impaired proprioception which leads to impaired balance and ultimately more susceptible to reinjure the ankle again. There is some indication that it is most advantageous to begin neuromuscular training during adolescence to train the body during a time of rapid musculoskeletal growth and decreased balance and coordination that occurs as a result of that growth [20]. Thus, the results of this study explains the value of the neuromuscular training on adolescent and young athletes especially the athletes with the history of previous injury.

CONCLUSION

Though the current study has many limitations including the small sample size and so on, the findings of the study also indicate that the early initiation of the proprioceptive neuromuscular training could improve the balance and consequently protect the young athletes from possible reinjury. Thus, we are recommending the early initiation of the proprioceptive neuromuscular training especially from the school level could be more beneficial to have proper neuromuscular system development and to prevent the possibility of reinjury among the adolescent and young athletes.

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REFERENCES

- [1] Garrick JG. The frequency of injury, mechanism of injury, and epidemiology of ankle sprains. *Am J Sports Med* 1977;5:241-42
- [2] Fong DT, Hong Y, Chan LK, Yung PS and Chan KM. A systemic review on ankle injury and ankle sprain in sports. *Sports med.* 2007, 37: 73-94.
- [3] Hertel J. Functional instability following lateral ankle sprain. *Sports Med* 2000;29:361-71
- [4] Bahr R, Bahr IA. Incidence of acute volleyball injuries: a prospective cohort study of injury mechanisms and risk factors. *Scand J Med* 1997, 7: 166-71
- [5] Hertel J. Functional anatomy, pathomechanics, and pathophysiology of lateral ankle instability. *J Athl Train* 2002;37:364-75
- [6] Hubbard TJ, Kramer LC, Denger CR, Hertel J. Correlations among multiple measures of functional and mechanical instability in subjects with chronic ankle instability. *J Athl Train* 2007;42:361-66
- [7] Smith RW, Reischl SF. Treatment of ankle sprains in young athletes. *Am J Sports Med* 1986; 14:465-71
- [8] Osborne MD and Rizzo TD. Prevention and treatment of ankle sprain in athletes. *Sports med.* 2003, 33: 1145-1150.
- [9] Griffin LY, Agel J, Albohm MJ, et al. Non-contact anterior cruciate ligament injuries: risk factors and prevention strategies. *J Am Acad Orthop Surg*, 2000; 8:141-150.
- [10] Hewett TE, Myer GD, Ford KR. Reducing knee and anterior cruciate ligament injuries among female athletes: a systematic review of neuromuscular training interventions. *J Knee Surg*, 2005; 18:82-88.
- [11] Lloyd DG. Rationale for training programs to reduce anterior cruciate ligament injuries in Australian football. *J Orthop Sports Phys Ther*, 2001; 31:645-654.
- [12] Goldie Pa, Bach Tm, Evans Om. Force platform measures for evaluating postural control: Reliability and validity. *Arch Phys Med Rehabil.* 1989; 70:510-517.
- [13] Tropp H, Ekstrand J, Gillquist J. Stabilometry in functional instability of the ankle and its value in predicting injury. *Med Sci Sports Exerc*, 1984; 16:64-66.
- [14] Watson AW. (1999). Ankle sprains in players of the field-games Gaelic football and hurling. *J Sports Med Phys Fitness*, 39:66-70.
- [15] Willems TM, Witvrouw E, Delbaere K, Mahieu N, De Bourdeaudhuij I, De Clercq D. (2005). Intrinsic risk factors for inversion ankle sprains in male subjects: a prospective study. *Am J Sports Med*, 33:415-423.
- [16] McGuine TA, Greene JJ, Best TM, Levenson G. Balance as a predictor of ankle injuries in high school basketball players. *Clin J Sport Med*, 2000; 10:239-244
- [17] Paterno MV, Myer GD, Ford KR, Hewett TE. Neuromuscular training improves single-limb stability in young female athletes. *J Orthop Sports Phys Ther*, 2004; 34:305-316.
- [18] Myer GD, Ford KR, Brent JL, Hewett TE. The effects of plyometric vs. dynamic stabilization and balance training on power, balance, and landing force in female athletes. *J Strength Cond Res*, 2006; 20:345-353.
- [19] Hewett TE, Paterno MV, Myer GD. Strategies for enhancing proprioception and neuromuscular control of the knee. *Clin Orthop Relat Res*, 2002; 402:76-94.
- [20] Myer GD, Ford KR, Hewett TE. Methodological approaches and rationale for training to prevent anterior cruciate ligament injuries in female athletes. *Scand J Med Sci Sports*, 2004; 14:275-285
- [21] Valovich McLeod TC, Armstrong T, Miller M, Sauers JL. Balance Improvements in Female High school basketball players after a 6-week neuromuscular training programme. *Journal of Sport Rehabilitation*, 2009; 18, 465-481.
- [22] Bell DR., Guskiewicz KM et al. Systemic review of the balance error scoring system. *Sports Health.* 2011; 3(3):287-295
- [23] Bressel E., Younker JC, Kras J, Heath EM. Comparison of static and dynamic balance in female collegiate soccer, basketball and gymnast athletes. *Journal of Athletic Training*, 2007; 42(1):42-46
- [24] Hoffman M, Payne G. The effects of proprioceptive ankle disk training on healthy subjects. *J Orthop Sports Phys Ther.* 1995; 21(2):90-93.
- [25] Hrysomallis C. Relationship between balance ability, training and sports injury risk. *Sports Medicine.* 2007; 37(6):547-556.
- [26] Mchugh MP, Tyler T, Mirabella M, Mullaney M, Nicholas S. The Effectiveness of a balance training intervention in reducing the incidence of noncontact ankle sprains in high school football players. *Am J Sports Med.* 2007; 35(8):1289-1294.
- [27] Sammarco GJ. *Rehabilitation of the foot and ankle.* Mosby-Year Book, Inc.: St. Louis, Missouri; 1995
- [28] Zachazewski J, Magee D, Quillen W. *Athletic injuries and rehabilitation.* W.B. Saunders Company: Philadelphia. 1996; 236-261.

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