Effects of Whole Body Vibration on Ankle's Proprioception in Elderly

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Abstract: Background: Falls are the most serious and frequent home accident among older people secondary to decreased proprioception, whole body vibration can be used for prevention. **Purpose:** the purpose of the study was to investigate the effect of whole body vibration on ankle's proprioception in elderly. **Materials and methods:** Thirty randomly healthy older males and females ranging between 64 and 75 years of age participated in this study. They were randomly divided into two equal groups, each contains fifteen participants. The first control **group (A)** adopted a squat position with frequency 0 Hz, the second experimental **group (B)** in addition to the squat position, received a vibration frequency 50 Hz, the amplitude was from 5 – 8 mm; the training period was for 2 months, 3 times per week and the vibration protocol was 5 minutes (1 min vibration, 1 minute rest for 5 minutes); Ankle proprioception was measured using the Biodex Isokinetic Dynamometer. **Results:** There was no statistical significance difference in the ANOVA test for **(group A)** pre and post treatment as the F value was 1.26 and P value was 0.29, while for **(group B)**, there was a statistical significance difference in the ANOVA test pre and post treatment as the F value was 9.34 and the P value was 0.0001. **Conclusion:** There was a significant effect of whole body vibration on ankle's proprioception in elderly.

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1- Introduction

Falls are the most serious and frequent home accident among older people. They are a major reason for admission to hospital or a residential care setting, even when no serious injury has occurred **[1].** Falls occur in approximately one third of adults over the age of 65 years and account for 65% of all injuries in this group[2].One-quarter to one-half of all falls can cause some injury; 10–15% of falls are associated with serious injury, 2–6% with fractures and around 1% with hip fractures**[3].** The elderly, who represent 12 % of the population, account for 75 % of deaths from falls. The number of falls increases progressively with age in both sexes and all racial and ethnic groups. The injury rate for falls is highest among persons 85 years of age and older**[4].** Impairment of muscle strength and power of the lower extremities and balance/postural control have been found to be important risk factors for falls and these parameters are known to become progressively more impaired with aging, and the age-related decrease in the muscle strength and power are known to be much more marked in the lower extremities than in the upper extremities **[5].** Proprioception represents an essential component of postural control, providing orientation information about movement and position of the joints and muscles [2]. Impaired proprioception leads to less accurate detection of body position changes increasing the risk of fall, and to abnormal joint biomechanics during functional activities, so over a period of time degenerative joint disease may result[6]. JPS determines the subject's ability to comprehend a presented joint angle and then, once removed, actively or passively, reproduce the same joint angle and sense of limb movement determines detection of passive motion of the limb **[6].** Decline of proprioceptive function may represent a fundamental aspect of the aging process **[7].** Altered neuromuscular control of the lower limb and consequently poor balance resulting from changes in the proprioceptive function could be related to the high incidence of harmful falls that occur in old age subjects [6]. Decline in lower limb proprioception had been linked to balance problems found in the elderly, which have, in turn, been associated with the higher incidence of falls[8]. The deterioration of proprioception throughout the human lifespan has deleterious repercussions on motor coordination and balance **[9]**. Whole Body Vibration (WBV) is a neuromuscular training method that has sparked new research interest as an intervention useful for many populations in the field of physical therapy **[10]**. In this form of training, the entire body is exposed to oscillating motions through the use of a vibrating platform upon which exercises can be performed **[10].** Research on the effects of WBV has been predominantly focused on muscle power and strength, body composition, electromyography, balance and functional mobility in all age distributions [11]. Recently, vibration training has been reinvented as a new form of exercise that is becoming more frequently used to improve muscle strength, power and flexibility as well as coordination [12]. The mechanical oscillations, termed "vibrations", was mentioned in ancient Greco-Roman as a medical technique. The first application of vibration was conducted by Granville in 1881 in the treatment of pain and subsequently employed in physical therapy to raise the excitability of the alpha and gamma motoneurons pools, thus permitting the patient to achieve greater voluntary control [13]. Over the last decade the use of mechanical vibration for training purposes have begun attracting interest and many researchers have studied its effects on the physical performance of trained and untrained people [13]. In recent history, the origin of this training goes back over 20 years, in Russia, where in the late 70s a lot of studies were done finding the effects of Body Vibration. Initially the studies were directed, one toward Vibration Training in various branches of sports (mountain biking or skating) the other toward the trainings and therapeutic methods of vibration training as mostly in the end of the 80s was done in the former Union of Soviet Socialist Republics USSR **[14]**. Whole Body Vibration (WBV) exposure has been proposed as a potentially safe, low intensity alternative to current modalities to combat Sarcopenia in exercise-intolerant, exercise-aversive or mobility- limited individuals, without the potential risks or behavioral barriers associated with high intensity exercise **[15].**

2- Subjects, materials and methods

Thirty older healthy participants' males and females ranging between 64 and 75 years of age participated in this study. The training on the Whole Body Vibration machine during the 2 months period was done at **The Hospital of Dar Al Ajaza Al Eslameyya in Beirut – Lebanon.** The participants were randomly divided into two equal groups; each group included fifteen participants: **Group A: Control Group (CG):** 15 participants performed a static squat exercise on WBV platform with 0 Hz frequency. **Group B: Vibration Group (VG):** 15 participants In addition to the static squat exercise participants were exposed to vertical sinusoidal WBV using a 50 Hz frequency. **The peak to peak amplitude** used in the WBV for the study group was ranging from 5 to 8 mm. Participants were trained on WBV for 8 weeks (3times/week). The exclusive criteria were: Age less than 64 years old, prosthesis participation in a resistance training program, a recent bone injury, fracture or joint replacement within the past 12 months, any cognitive impairment, pacemaker, current kidney or gall stones, blood clot or thrombosis within the last 6 months, and amputation of lower extremities other than toes. The Biodex Isokinetic Dynamometer system used to assess the active repositioning test (proprioception for ankle joint)**.**The participants were exposed to vertical sinusoidal WBV using Crazy Fit machine. The position tested was 15 degree of inversion from neutral position **[16, 17].** Prior to being tested, each subject received a practice session followed by a 30-second rest period and then continued on to the active reposition tests. Subjects' proprioception were tested twice[16, 17, and 18]. During the ankle joint repositioning test, each subject was asked to concentrate on his ankle and actively move it to the test position as in the practice session **[16, 17, and 18].** In order to adequately stimulate joint and muscle mechanoreceptors during voluntary ankle movement, the angular speed for the active reposition test was set at 500 degree/second (the highest speed setting for the proprioception test in the Biodex Isokinetic to minimize any additional resistance from the testing apparatus positions [16, 17]. The subjects were positioned half sitting on a modified examination table with the lower leg parallel to the floor **(Fig.1).** This arrangement enabled proper placement of the subject's foot into the Biodex ankle inversion/ eversion apparatus with the ankle plantar flexed 25 degree feedback **[16].** After the subject's foot was properly aligned with the axis of the isokinetic dynamometer, according to the manufacturer's guidelines, straps were placed around the proximal tibiofibular joint and forefoot to provide stabilization. Subjects were required to close their eyes and wear an eyeshade during the testing procedures to eliminate visual feedback **[16]**.

Before the application of the vibration intervention, all participants attended a familiarization session, where they were instructed in the correct half squat position; visually monitored knee angle of 100 degree which was held constant during the 60-second exposure and across all experimental conditions, standardized 5-minute cycle ergometer warm-up. Participants were assigned to one of the two groups (one experimental intervention groups and one control group) for two months period. WBV exposure is intermittent (1minute vibration: 1 minute rest for 5 min, 3 days a week for 2 months).The control trial will adopt the same position on the vibration plate for the same duration; however, the plate was turned off. All participants stood on the vibration platform **(Fig.2)** with their feet shoulder width apart, hands by their sides, and wore standardized thick cotton socks to prevent any dampening that might result from footwear [19].

Fig.1: Positioning of the ankle on the Inversion/eversion apparatus

Fig. 2: Standing on the vibration platform

3- Results

For group (A) the mean of proprioception from 0 to 15 degree inversion pre-treatment was (20.86±10.4); the proprioception from 0 to 15 degree inversion after 1 month was (21.06±9.36); the proprioception from 0 to 15 degree inversion after 2 months was (19.93±8.85); and finally the proprioception from 0 to 15 degree inversion 2 months after the end of the treatment was (20.4±8.3).For group (B) the mean of proprioception from 0 to 15 degree inversion pre-treatment was (20.8±7.09); the proprioception from 0 to 15 degree inversion after 1 month was (18.93±6.49); the proprioception from 0 to 15 degree inversion after 2 months was (15.4±4.01) and finally the proprioception from 0 to 15 degree inversion 2 months after the end of the treatment was (16.46±4.77).The within subjects change of the proprioception from 0 to 15 degree inversion pre-treatment, after 1 month, after 2 months, and 2 months after the end of the treatment are presented by application of the repeated measurement ANOVA as shown in **table (1).** For group (A), repeated measurement ANOVA revealed no significant change in proprioception from 0 to 15 degree inversion as the F value was 1.26 and P value was (0.29), while for group (B) there was a significant change in proprioception from 0 to 15 degree inversion as the F value was 9.34 and P value was (0.0001).

To reveal the differences between the proprioception from 0 to 15 degree inversion pre-treatment, after 1 month, after 2 months, and 2 months after the end of the treatment Bonferroni post hoc test was conducted for group (B) only. For group (B) there was no significant difference of proprioception from 0 to 15 degree inversion values between pre-treatment value and after 1 month value as t-value was (1.65) and p-value was (P>0.05) , there was a significant difference of proprioception from 0 to 15 degree inversion values between pre-treatment value and after 2 months value as t-value was (4.79) and p-value was (P<0.001), there was a significant difference of proprioception from 0 to 15 degree inversion values between pre-treatment value and after 2 months of the end of the treatment value as t-value was (3.84) and p-value was (P<0.01), there was a significant difference of proprioception from 0 to 15 degree inversion values between after 1 month value and after 2 months value as t-value was (3.13) and p-value was (P<0.05), there was no significant difference of proprioception from 0 to 15 degree inversion values between after 1 month value and 2 months after the end of the treatment value as t-value was (2.19) and p-value was (P>0.05), and finally there was no significant difference of proprioception from 0 to 15 degree inversion values between after 2 months value and 2 months after the end of the treatment value as t-value was (0.94) and p-value was (P>0.05).

Table (1): Repeated measurement ANOVA of proprioception from 0 to 15 degree inversion pre-treatment, after 1 month, after 2 months, and 2 months after the end of the treatment for both groups (A and B).

Group	Source of variation	SS	DF	MS	F	P	S
Group (A)	Within subjects	11.53	3	3.84			
	Between subjects	4677.7	14	334.12	1.26	0.29	NS
	Error	127.47	42	3.03			
Group (B)	Within subjects	266.73	3	88.91			
	Between subjects	1440.9	14	102.92	9.34	0.0001	S
	Error	399.77	42	9.51			

*SD: Standard deviation *P: Probability *S: Significance *NS: Non-significance.

4- Discussion

From 0 degree to 15 degree inversion position, the study revealed no significance difference in ankle proprioception in the control group (A) while there was a significant change in ankle proprioception in the experimental group (B) after 2 months training.These findings support the results of a study that found a single five-minute bout of WBV (18 Hz) combined with static, closed chain exercise improved lumbosacral proprioception, that's possibly because of the small amount of WBV given to the people in his study[(20)]. Another support between the actual study and another study of that concluded that 12 weeks improved proprioception of the lumbo-pelvic area in adult people[(21)].A study proved that high frequency WBV exercise, 3 minutes a day was effective in improving the balancing ability and proprioception in elderly women and reduce risks of all, which support this study[(22)]. Another study that agree with this study found a positive effect of WBV on proprioceptive function in ACL-reconstructed athletes[(23)]. A study of elderly people that a WBV training program with frequency of 12-20 Hz, after 2 months training, the proprioception (maximum standing time on one leg) was improved which explain and support this study[(15)].Another study reported that adding whole body vibration to a simple weight bearing exercise enhances lumbo-sacral position sense after a single 5 minute WBV session and that supported the findings of this study[(24)]. In the other hand, it was found that WBV in young healthy [(18)] did not affect Joint Position Sense (JPS) which contradicted with the findings of this study, which may be explained by the sample's age between both studies. The data analysis shows that the improvement mainly was clear at the end of the training, it may be concluded that 1 month training is not enough to improve the proprioception and in the other hand after stopping the treatment, the proprioception tend to decrease again and that may suggest a continuous vibration training.

5-Conclusion

At the end of this study, it can be deduced that whole body vibration exercise improves the ankle's proprioception in elderly.

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